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ABSTRACT

In 1978 Congress directed the National Science Foundation to conduct a national needs assessment of science education in two-year colleges. Volume I of the final report describes the design of the study, the findings, and the recommendations. A separate volume, Volume II (SE 033 604), contains appendices which provide supporting materials, as well as supplementary tabulations of data. Part of the evaluation plan involved the selection of colleges, students, and faculty. Invitations to participate in the study were extended to 240 colleges and usable replies were received from 168 of them. Questionnaires were developed to solicit information from three sources - institutional data (supplied by college officials), data from a sample of faculty, and data from a sample of students. This information is presented in three separate chapters, and a final chapter summarized major findings and recommendations. Results of the study revealed that faculty members generally were satisfied with their environment despite heavy teaching loads. Students generally were satisfied with their courses, but often lacked adequate language, study, and math skills. There was evidence of a need for improvement in most fields, particularly a need for better equipment, facilities, and faculty development. (Author)

A COMPREHENSIVE ASSESSMENT OF SCIENCE EDUCATION IN THE TWO-YEAR COLLEGE

Volume I: Technical Report

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ACKNOWLEDGEMENTS

This final report is the culmination of 18 months of work by a number of individuals in a variety of roles. Each person played a very significant part in the success of this project.

Initial thanks go to the project staff members who were responsible for the design, data collection, and analysis activities related to the study effort. Ms. Katalin Losonczy was responsible for the design and conduct of the data collection portion of the study. She was ably supported by Lucinda Price, Fran Brennan, Pam Witt, and others in the receipt control, coding and editing and data retrieval portions of the project.

Responsibility for producing the final data base that was used for the analysis rested with Daniel Hawes. This was a major effort requiring the manipulation of three separate files and many variations within those files. His performance on this task is best reflected by the exceptional report which is presented in the two volumes of data available to the reader.

The major analysis and report writing were carried out by Dr. Howard Hausman, who was the major consultant to this study and Dr. Samuel Peng, who is a senior research associate on the Westat staff. Both individuals were instrumental in developing the design for the analysis and in carrying out the actual analysis of the data. The information presented in both Volume I and Volume II is the result of long hours of wading through table after table of cross tabulations and perseverance in being able to "pull out the nuggets" that are presented in this report.

The report, however, would never be what it is today without the dedication of two individuals and the incredible amount of time and effort that they contributed to the study. Ms. Delia Schofield, who was the technical editor, and Ms. Patricia Congdon, who was the project secretary, suffered through what seemed like an endless number of revisions, updates, changes, and just about every kind of delaying tactic known to project reporting. Their cheerfulness and willingness to go well beyond the bounds of what is normally required for this kind of a study is truly appreciated.

Mr. Stephen Hadley and Mark Jolin had the responsibility for the preparation of the graphic portions of the report which play a major role in the clarity of the presentation. The outstanding quality of their work is quite evident throughout the two volumes of material.

Last, but not least, I would like to thank both the advisory panel members who included: Drs. Evelyn M. Hurlburt, William A. Wockenfuss, Walter V. Hohenstein, Melvin F. Tuscher, Malcolm Goldberg, Robert L. Gell, Ralph H. Lee, Lewis R. Fibel and Mr. Arthur F. Uelner, Stanley Pritchard and Kenneth Chapman, the Project Officer, Mr. William Aldridge, and Ms. Peggy Dixon, a project consultant, who were all responsible for extremely valuable advice and guidance during the early stages of the project. These individuals were influential in the design of the questionnaire and helping us develop procedures for obtaining the responses from the participating institutions.

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1. INTRODUCTION

1.1 Background of the Study

Two-year colleges have become major sources of science education in this country. Approximately 1,300 of these colleges currently enroll more than four million students -- one-third of the total undergraduate population, and approximately two-thirds of the freshmen in all institutions of higher education.[1] Many two-year college students are enrolled in traditional transfer programs leading ultimately to baccalaureate degrees. Most of these students take degree-credit science courses, and many eventually may earn science-related B.S. or B.A. degrees.

An increasingly large proportion of two-year college students is enrolled in occupational and technical programs. According to data from the American Association of Community and Junior Colleges (AACJC), 50 percent of all two-year college students were enrolled in such programs in 1976, compared to only 13 percent in 1965.[2] A fairly large number of these students are in science- and engineering-related programs. Traditional science courses, as well as science-related community service programs and interdisciplinary studies, also have attracted noncredit students, whose numbers have expanded rapidly in recent years.[3]

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[1]Andrew Hill, Science Education in Two-Year Colleges: Psychology (Los Angeles: Center for the Study of Community Colleges, and ERIC Clearinghouse for Junior Colleges, 1980), p. 1.

[2]American Association of Community and Junior Colleges, Fact Sheets on Two-Year Colleges (Washington, D.C.: AACJC, 1976).

[3]Florence B. Brawer and Jack Friedlander, Science and Social Science in the Two-Year College (Los Angeles: Center for the Study of Community Colleges, and ERIC Clearinghouse for Junior Colleges, 1979), pp. 1-2.

Despite the important role of two-year colleges in science education, little is known about the adequacy and needs of science programs in these colleges. Currently available national statistics on these institutions are too general to draw specific conclusions about science programs. Most estimates of the proportions of students enrolled in science programs or classes are out-of-date, and more importantly, such estimates tell nothing about the characteristics of science students (their ages, educational goals, perceptions of the effectiveness of their education) in the wide variety of science and technology programs offered by two-year colleges. One of the few studies that has examined some of these issues was conducted by the Conference Board of the Mathematical Sciences. This organization conducted three surveys, in 1965, 1970, and 1975, which collected data on enrollments in undergraduate mathematics courses.[4]

Similarly, little information exists about science faculty and about the resources available for science education in two-year colleges. When the two-year college movement began its rapid growth in the 1950s and 1960s, faculty members were recruited from the ranks of high school teachers. A widespread impression exists that the senior faculty members are these former high school teachers. Faculty positions later were filled from another group of people, frequently young men and women with newly obtained master's degrees, although quite a number had Ph.D.'s. It is fair to ask how well prepared many faculty members are to teach academic science in their fields, especially since their teaching and advising responsibilities significantly differ from those of four-year college faculty members. A large proportion of two-year college students in

[4]James T. Fey, Donald J. Albers, and John Jewett, Conference Board of the Mathematical Sciences. Report of the Survey Committee, Volume V. Undergraduate Mathematical Sciences in Universities, Four-Year Colleges, and Two-Year Colleges, 1975-76 (Washington, D.C.: Conference Board of the Mathematical Sciences, 1976).

science classes are not oriented toward baccalaureates, aiming either for career programs or for continuing education to improve their job prospects. Are faculty members fully qualified to handle these diverse course emphases? Are they in need of in-service education, and, if so, how readily available is it?

The National Science Foundation explored some of these issues in a 1967 survey of the experience and employment characteristics of junior college science, engineering, and technology faculty.[5] A more recent study, funded by NSF, the U.S. Office of Education, and the National Institutes of Health, examined hiring patterns of new full-time faculty.[6] The studies conducted by the Conference Board of the Mathematical Sciences collected some data on mathematics faculty. However, none of these studies offers particularly current or comprehensive information about faculty needs or about faculty members' perceptions of two-year colleges and students.

The institutional strength of two-year colleges varies tremendously. Some possess resources that have permitted the building and staffing of impressive facilities, while others have commenced operation in borrowed facilities and constructed their plants piecemeal. With the recent fiscal problems plaguing higher education, plans for rebuilding at times have been curtailed or postponed. In addition to adequacy of facilities, adequacy of staffing also requires investigation. Staffing adequacy involves not only backup instructional staff, but also the heavy teaching loads of faculty in two-year colleges. The 12- and 15-credit-hour teaching load is common, whereas four-year college faculty members tend to have lighter loads. It is

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[5]National Science Foundation, Junior College Teachers of Science, Engineering, and Technology, 1967. Experience and Employment Characteristics (Washington, D.C.: National Science Foundation, 1968).

[6]Frank J. Atelsek and Irene L. Gomberg, New Full-Time Faculty 1976-77: Hiring Patterns by Field and Educational Attainment (Washington, D.C.: American Council on Education, 1978).

important to determine whether this difference in teaching loads affects the quality of education. More specifically, we need to ascertain how faculty members contribute to science program structures and course design.

The paucity of existing information sources about science education in two-year colleges has been a matter of concern to policymakers. Congress directed the National Science Foundation, in the Foundation's Authorization Act for FY 1978, to conduct a national needs assessment of science education in two-year colleges.[7] In explanation of this requirement, it was stated that

> "The comprehensive assessment of science education in two-year colleges will provide the basis for an understanding of the unique role of those colleges in science education and the problems they face. The results are to be used to assess the effectiveness of current science education programs and to make those programs more relevant to the needs of two-year colleges. With the assistance of an ad hoc advisory committee of representatives of two-year colleges and science educators, it is expected that NSF will conduct a local needs assessment and a national needs assessment, thereby giving both in-depth and national scope to the study.
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> . . . . .
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> "In the national needs assessment one or more grants should be awarded for comprehensive national surveys on selected topics designed to yield an understanding of the needs of two-year colleges in science education. Relevant questions may include types and needs of students, types of programs, needs and character of faculty, and measures of programs effectiveness."[8]

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[7]National Science Foundation Authorization Act, FY 1978, Public Law 95-99.

[8]Conference Report 95-504, 95th Congress, First Session, July 20, 1977, pp. 15-16.

1.2 Objectives of the Study

This study was conducted to collect the information needed by policymakers and educators. Its primary purpose was to identify the role of two-year colleges in science education and the extent to which they fill that role. The results of the study will provide a basis for understanding the functions, programs, and teaching methods of science education in these colleges.

A number of questions were addressed in the study; as indicated in the list presented below, they generally fall into three categories (institutions, faculty, and students):

a. Questions pertaining to <u>INSTITUTIONAL</u> support of science education in two-year colleges.

- What resources are available in two-year colleges for science education?
- What are the characteristics of the instructional environment in terms of teaching loads, working conditions, availability of laboratory and clerical assistance, and diversity of responsibility of faculty?
- How does the instructional environment affect the quality of science education?
- What are the curriculum development and equipment modernization requirements of two-year colleges if they are to meet the needs of their clientele for science education?
- What is the role of the laboratory in two-year college science education, and what are the trends in lab use?
- What changes or improvements are needed in science laboratory facilities and equipment?

- Who are the key agents in the creation and design of science courses and science-related curricula in two-year colleges?

- How effective are present mechanisms for creating and designing science courses and curricula in terms of student needs and interests, as well as institutional capability to implement programs?

b. Questions pertaining to social science, natural science, mathematics, engineering, and technology FACULTY in two-year colleges.

- What are the characteristics of faculty in terms of subject matter preparation and its currency, formal training in science and pedagogy, age, years of experience, and interests?

- How closely are these characteristics matched to the interests, objectives, and abilities of students? What special needs remain to be met?

- What are science faculty perceptions concerning areas of greatest need?

- How different are characteristics of faculty who are teaching science service courses for students in occupational programs?

- What in-service education programs are available?

- Do in-service education programs meet existing needs, and are they accessible?

c. Questions pertaining to social science, natural science, mathematics, engineering, and technology STUDENTS in two-year colleges.

- What are the characteristics of students enrolling in science courses or programs in two-year colleges in terms of age, maturity, racial or ethnic background, and prior levels of achievement in mathematics and science?

- What is the range of interests and objectives of two-year college science students? How do these differ among important subgroups of the two-year college student population (e.g., age, sex, field of study) and among types of institutions? What percent of the science students plan to transfer to four-year institutions?

- How closely do the existing science education programs match the interests and objectives of two-year college science students?

- How do students evaluate science education? Are they satisfied with the courses they are taking?

1.3 An Overview of This Report

These and other issues are examined, based on data collected from samples of two-year college administrators, faculty members, and students in science education. The study procedures and findings are presented in the following chapters. Chapter 2 describes the study sample, instruments, data collection procedures, and strategies used in analyzing the data. Chapter 3 describes the characteristics of participants in science education programs, and Chapters 4, 5, and 6 present the findings of the needs assessment of science education in two-year colleges. Each of these chapters is organized according to three categories: college administrators, faculty, and students. Chapter 7 summarizes the findings and presents recommendations. Supporting materials, such as data sources for sample selection and survey instruments, as well as supplementary tabulations of data, are included in Volume 2 (Appendices).

2. METHOD OF THE STUDY

2.1 Overview

To assess the needs of two-year colleges in science education, a survey of colleges was conducted to obtain information from three sources:

- A sample of two-year colleges, with institutional data supplied by an official appointed by each college;
- A sample of faculty members selected from the college sample; and
- A sample of students, selected from a designated class section of each instructor in the faculty sample.

Data were collected during the spring session of 1979, between April 15 and May 31. Invitations to participate were extended to 240 colleges, and 183 agreed to do so. Each of these colleges sent its course catalogue, schedule of spring classes, and the name of a college official who would coordinate the survey on the campus and also answer questions about the institution. Complete sets of questionnaires for institutions, faculty, and students were sent to survey coordinators at these 183 colleges. Usable replies were received from 168 colleges, a response rate of 90.8 percent. (The response rate based on the initial sample of 240 colleges was 70.0 percent.) Of the 974 faculty members to whom questionnaires were sent, replies were received from 831 (85.3 percent). Student questionnaires were distributed to 3,896 students, with 3,238 (83.1 percent) returning usable data.

In addition to data on the status and needs of science education, as perceived by college administrators, faculty members, and students, data on faculty members' and students' background characteristics also were collected. The returned questionnaires were processed, and three separate data files were created for analysis.

The analyses are primarily descriptive, consisting of tabulations of percentages, means, and ranges. Wherever deemed meaningful, statistics are presented for various subgroups defined, for example, by educational fields, types of colleges, and individuals' sex and racial or ethnic groups. All statistics are weighted to provided unbiased estimates of population values.

The following subsections summarize the methods used in the study and include descriptions of the samples, survey instrumentation, survey procedures, and analysis strategies. More detailed information is presented in Volume 2 (Appendices).

2.2 Sample Design

The sample design for this study has taken into account the fact that there are multiple sources of information (colleges, faculty, students). The analysis needed to account for all the study variables, while providing for their comprehensible cross classifications. Thus, a nested sample design was chosen as the most appropriate approach.

A detailed technical description of the sample design can be found in Volume 2, Appendix A. A brief discussion of the sample selection is presented below.

2.2.1 Sample of Colleges

The sample of colleges was selected from all public and nonproprietary private two-year colleges stratified by the following characteristics:

- Type of control (public vs. private);
- Geographic location;
- Type of institution (comprehensive vs. technical); and
- Size of student population (number of full- and part-time students enrolled in credit courses).

The unit for the college sample was the individual college campus -- a single, educationally self-sufficient campus with its own buildings, administration, and faculty. The questions asked in this survey about facilities and program offerings could have been answered only with respect to a specific campus and not to a college system as a whole.

The source used to select the sample was the 1979 edition of the Directory of Community, Junior, and Technical Colleges, published by the American Association of Community and Junior Colleges (AACJC). The 1979 edition contained information on 1,245 colleges, including student enrollment current as of the fall semester, 1978.[1]

In selecting the sample for the study, size of college (number of full- and part-time students enrolled for credit) was one prominent factor. Of the colleges listed in the AACJC directory, 44 percent have fewer than 1,500 students, while 13

[1]See Volume 2, Appendix B for discussion of lists of two-year colleges and potential sources for drawing a sample.

percent have more than 7,500 students. However, almost half of all students attend the relatively few colleges with large enrollments. In order to obtain a balanced picture of the facilities and programs offered to the entire student population, without obscuring conditions at small institutions, it was decided to oversample the larger colleges. The resulting distribution of the initial sample of colleges, classified according to enrollment size, program type and source of control, is shown in Table 2-1.

A sample of 200 colleges was desired for the study, and so the initial selection of the sample contained an overage of 20 percent, or 240 colleges. Each of these 240 schools was invited to participate in the survey. By the cutoff date, 185 had agreed to do so. During the final data collection, usable replies were received from 168 colleges. Distribution of the responding colleges also is shown in Table 2-1.

There are some differences in response rate for certain categories of colleges between the initial sample of 240 colleges and the responding sample. Private colleges, constituting only 12 percent of the sample for both technical and nontechnical types, responded at a rate of 59 percent, whereas the rate for public colleges was 72 percent. The very small colleges (enrollment under 500) responded at a rate of 47 percent, with the public colleges in this group responding less frequently than the private ones.

Due to incomplete data in the <u>Directory of Community, Junior, and Technical Colleges</u>, corrections of classification for some of the responding colleges were necessary. Because a number of multicampus systems were not listed as such when the directory was printed, and because in other instances student enrollments were not given for individual campuses of a system but only for the whole system, corrected figures on campus size were supplied

College size	Public comprehensive		Public technical		Private comprehensive		
	Respond-ing	Initial sample	Respond-ing	Initial sample	Respond-ing	Initial sample	Respo in
001-499	1	3	0	1	6	10	0
500-1,499	16	25	5	9	7	10	0
1,500-2,499	19	24	4	6	2	4	0
2,500-4,999	30	38	7	7	2	3	0
5,000-7,499	19	29	2	2	0	0	0
7,500-14,999	31	41	1	1	0	0	0
15,000 and over	15	23	1	2	0	0	0
Total							
Number	131	183	20	28	17	27	0
Percent*	71.6	-	71.4	-	63.0	-	0.0

*Percent responding (e.g., 131 ÷ 183 x 100 = 71.6).

**Percent responding, by size (e.g., 7 ÷ 15 x 100 = 46.7).

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by the colleges. In addition, a few colleges listed as comprehensive in the directory were reclassified as technical institutes, based on the colleges' descriptions of their programs. As a result, the corrected classifications reported in Table 2-2 differ from those used originally for the responding sample. All analyses of data used the corrected classifications of colleges.[2]

2.2.2 Sample of Faculty

Various approaches were considered for drawing samples of faculty members and students. Faculty members could have been chosen randomly from lists of faculty members provided by the colleges (ensuring, of course, that only those teaching in the spring quarter or semester were selected), with further random selection of students in a class section taught by each faculty member sampled. This method, however, would have given part-time and off-campus faculty a chance of selection equal to full-time staff members, even though full-time faculty teach on the average two to four times as many courses as the part-time teachers and usually do so on-campus. This approach also might have oversampled students from class sections taught by part-time faculty. In addition, it is quite possible that some colleges might have omitted from their lists the names of some part-time or off-campus faculty, which then would have eliminated whole blocks of students from the survey.

Therefore, it was decided to draw a sample of class sections offered in the targeted fields on- and off-campus, in day and evening sections, and at unconventional times (e.g., weekends). The teachers of the selected class sections became the faculty sample (arrangements were made to avoid selecting the

[2]Procedures used to correct size and type classifications of colleges are given in Volume 2, Appendix C.

Table 2-2. Corrected classification of two-year colleges in responding sample: numbers and percents of colleges, by size, source of control, and type of program (N=168)

College size	Public comprehensive	Public technical	Private comprehensive	Private technical	Corrected total	
					Number	Percent
1-499	1	1	5	0	7	4.2
500-1,499	16	5	8	0	29	17.3
1,500-2,499	17	5	1	1	24	14.3
2,500-4,999	29	7	0	0	36	21.4
5,000-7,499	20	4	1	0	25	14.9
7,500-14,999	28	4	0	0	32	19.0
15,000 and over	14	1	0	0	15	8.9
Corrected total						
Number	125	27	15	1	168	-
Percent	74.4	16.1	8.9	0.6	-	100.0

same instructor twice), and students in those class sections formed the basis for the student sample.

The class sections were selected separately in five broad curriculum areas:

- Life sciences (including all subfields of academic biology, health sciences, and agriculture);
- Physical sciences;
- Engineering and technology (excluding technical trades);
- Mathematics and computer sciences; and
- Social sciences.

The numbers of course sections and, consequently, the number of teachers selected in each field, and the numbers of responses are given in Table 2-3. Particularly noteworthy is the response rate of 94 percent for teachers in the 168 colleges who are known to have received the questionnaires.

The class sections were selected by first listing all course sections within a curriculum field for all colleges and then selecting randomly the appropriate number of course sections in that field. This method provided a sampling of faculty and students across colleges for each of the broad curriculum areas. Adjustments were made so that each college had no fewer than two class sections in the sample and no more than ten across all five curriculum fields.

Since selection of faculty has been tied inextricably to discipline and curriculum areas, an explanation of course selection problems and their resolution is in order at this

Table 2-3. Numbers of faculty questionnaires distributed and received, and response rates, for five curriculum areas

Curriculum area	Number in original sample of colleges (183 colleges)	Number in responding sample of colleges (168 colleges)	Number returning questionnaires	Percent (based on 168 colleges)	Percent (based on 183 colleges)
Life sciences	214	199	189	95.0	88.3
Physical sciences	195	177	167	94.4	85.6
Engineering and technology	199	179	169	94.4	84.9
Mathematics and computer sciences	197	176	165	93.8	83.8
Social sciences	169	152	141	92.8	83.4
Total	974	883	831	94.1	85.3

point. In general, only courses that were applicable to two-year college degrees were eligible for inclusion. (This condition did not really eliminate courses in one-year certificate programs, since certificate courses also are required in degree programs, and students in such courses may be enrolled in either type of program.) In addition, only those class sections that met for the entire spring quarter or semester during which data were collected could be included. Some standardization of questionnaire administration was necessary, for the student questionnaire contained items that could only be answered sensibly after a few weeks in class, and experience has shown that questionnaires received during the final two weeks of a session are likely to be unanswered in the excitement of final exams. Thus, courses that met for a portion of the quarter or semester, such as one- or two-credit "mini-courses" and refresher courses offered in some career fields, were eliminated.

Deciding which courses to include posed different problems for each of the broad curriculum areas, in many cases resolvable only by a college-by-college analysis. The decision rules followed for each of the five broad fields are summarized in Exhibit 2-1, included at the end of this section (p. 2-18).

Treatment of laboratory sections in the life sciences, physical sciences, and engineering and technology fields depended on the format of the class schedules supplied by the individual colleges. In many colleges, laboratories were listed separately from lecture/discussion sections, and in these cases each section (laboratory and lecture/discussion) was counted as a separate class section. In other colleges, labs and lectures/discussions were combined in the course schedule, and for this survey they were treated as single units.

In dealing with career programs in the health fields, agriculture, and engineering and technology, it was decided to eliminate from the study all curricula (and the courses unique to them) that commonly are classified as being directly related to vocational trades, but to include those that are accepted as technologies for which two-year degrees are conferred. The line between trades and technologies at times depends on the observer's viewpoint; agreement among experts is limited. Decisions in this study relied largely on the individual college's treatment of the curriculum. If the institution awarded two-year degrees in the curriculum, it was accepted, and the courses credited toward that degree therefore were included. In some career fields (e.g., in the mechanical and construction fields), award of a degree is not consistent among colleges with apparently similar programs. Basing the decision of which courses to include on the colleges' own practices incorporates this inconsistency into the survey, but arbitrary decisions based only on college catalogue descriptions of courses and programs may introduce some unknown biases.

Another problem arose in dealing with classes held off-campus and at unconventional times. Weekend courses were accepted if they extended over the entire spring session. However, to accommodate community needs, some two-year colleges offer courses in compressed, intensive sessions. Two to four entire weekends may be devoted to a semester's work in one or two courses, or the same content may be packed into one or two weeks of all-day schooling. In these cases the number of instructional hours may be the same as for those classes stretched out over the entire quarter or semester. However, because the questionnaires were administered at one time for each institution, courses not adhering to the regular spring calendar could not be included.

Courses offered at off-campus locations usually were included. The exceptions were courses in some health and technology fields, where credit was allowed for practical or clinical experience conducted on a one-to-one basis in hospitals or at industrial locations. These courses were excluded, since student sampling obviously was not possible with a single student in a section. Another exception was low-level, nondegree math and technology (or trade) courses.

2.2.3 Sample of Studen_s

Selection of students was confined to the class sections chosen within each of the five broad curriculum areas from which the faculty sample also was drawn. Each faculty member in the sample was asked to give student questionnaires to four students in the selected class. These students were chosen randomly from within the class according to a set of instructions given to the teacher (see Volume 2, Appendix E). To compensate for varying class sizes, a table was provided presenting the method of student selection based on the number of students in the class. A total of 3,532 students were given questionnaires.

Response rates for the students were fairly uniform among the fields. Table 2-4 shows the numbers of students in the 168 responding colleges to whom questionnaires were distributed and the numbers who returned them, by curriculum area. The response rate, based on the initial number of students in these 168 schools, was about 92 percent. The loss of student responses is attributable in about equal proportions to 1) the failure of instructors to respond (in which case all four student responses were lost); and 2) the failure of usually one of the four students to complete and return the questionnaire.

Table 2-4. Student sample: numbers of students selected and numbers responding, by broad curriculum area

Curriculum area	Selected*	Responding	Percent
Life sciences	796	729	91.6
Physical sciences	708	642	90.7
Engineering and technology	716	671	93.7
Mathematics and computer sciences	704	644	91.5
Social sciences	608	545	90.3
Total	3,532	3,235	91.6

*Selected from the 168 colleges that participated in the study.

2.3 Instrumentation

Data were collected by three questionnaires. The institutional questionnaire was designed to be completed by a representative of the college who had an overview of its educational program in the science and technology areas. This questionnaire primarily tapped information on educational fields that need improvement and on the types of improvement required. The faculty questionnaire was general enough to be meaningful to faculty in all the scientific disciplines, mathematics, technologies, and social sciences, focusing on those elements that are of particular importance to the sciences and on areas in need of improvement. The student questionnaire was intended for any student enrolled in any course within the defined areas of science and technology. The questionnaire included items on student background characteristics, as well as on needs for improvement in science education, as perceived by students. The questionnaires used for the study are included in Appendix E.

Questionnaire content was developed by a process of logical analysis and incorporated appropriate topics from a variety of sources. After the first draft of each questionnaire had been framed, it was submitted to the Project Advisory Panel for review. The comments from the Advisory Panel and NSF program staff were incorporated into the revisions of the questionnaires, which were tried out in a few local colleges (nine or fewer trial respondents for each questionnaire). The final versions of the questionnaires then were submitted to OMB for approval.

2.4 Survey Procedures

After the questionnaires were approved by NSF and OMB, they were printed and mailed to 183 participating institutions, together with appropriate instructions. The complete mail survey package consisted of:

- One institutional questionnaire;
- A faculty questionnaire for the instructor of each class section selected in that college (up to ten per college);
- Four student questionnaires for each faculty member selected;
- Appropriate letters for each questionnaire explaining the purpose of the study, requesting cooperation, and providing brief instructions;
- A set of instructions for each faculty member on how to select four students from his or her class, together with a table of numbers to use in the selection;
- Envelopes for respondents to enclose the questionnaires and to ensure privacy; and
- Instructions and mailing materials for use by the institution's survey coordinator to return the completed questionnaires.

The full-scale mailout of the package began on April 15, 1979. The mailout was followed first by reminder cards and then by phone calls to the institutions that failed to respond after a few weeks. By May 31, 1979, 164 colleges had returned usable questionnaires. This number included 164 institutional questionnaires, 831 faculty questionnaires, and 3,238 student questionnaires. These questionnaires were coded manually, edited, and keyed into computer files. These files, separately prepared for institution, faculty, and student questionnaire data, were edited further by computer programs to verify the proper codings, ranges, and logic of responses. Problems or errors were resolved by checking the responses given in the questionnaires and by imputation based on available information. The final clean data files were used for analyses.

2.5 Analysis and Presentation of Results

The study results are presented in four chapters. Chapter 3 is a description of important characteristics of colleges, science faculty, and students enrolled in science courses. Chapters 4, 5, and 6 analyze the general and specific needs of two-year colleges in the sciences, as perceived by institutional administrators (Chapter 4), faculty (Chapter 5), and students (Chapter 6). Chapter 7 integrates the major study findings and presents recommendations for future program considerations.

For ease in presentation, colleges have been grouped into five categories reflecting a combination of institution type and size. These categories are:

- Technical institutes;
- Private colleges (nontechnical);
- Public comprehensive, small (up to 1,499 students);
- Public comprehensive, medium (1,500 - 7,499 students); and
- Public comprehensive, large (over 7,500 students).

Since the numbers of both private colleges (nontechnical) and technical institutes are small in the sample, as well as in the population of two-year colleges, they have been grouped into single categories disregarding college size. In fact, all but two of the 15 private colleges have fewer than 1,500 students, a proportion that corresponds exactly to that found for all private colleges in the AACJC directory. The public and private technical colleges, whose programs and students are highly similar, have been combined into a single class of technical institutes.

All statistics presented in the following sections are properly weighted to provide unbiased estimates of population values. For example, each college in the sample has been weighted by a factor determined by the category of college it was intended to represent. The numbers of colleges by type, therefore, totals 1,232. A description of the weighting procedures is contained in Volume 2, Appendix F.

Analyses involving faculty and student questionnaires are shown both by type of college and by educational field. The original five fields described in Section 2.2.2 were further refined to allow for a finer breakout of the life sciences, mathematics, and computer sciences. Eight fields of study are reported separately, as follows:

- Introductory biology
- Health sciences
- Other life sciences (advanced biology and agriculture)
- Physical sciences
- Engineering and technology
- Mathematics
- Computer sciences
- Social sciences

Exhibit 2-1. Rules for inclusion of courses, by broad curriculum fields

Field I: Life Sciences

Include all courses offered in academic disciplines in arts and sciences curricula (e.g., biology, biological sciences, botany, physiology, zoology, microbiology); service courses in these disciplines credited toward degrees in occupational programs; all degree courses in the health sciences; all degree courses in agricultural sciences dealing with plant or animal life; and interdisciplinary courses, including those in environmental sciences having major life science components.

Field II: Physical Sciences

Include all courses offered in academic disciplines in arts and sciences curricula (e.g., astronomy, chemistry, earth science, geology, physics, meteorology); services courses in these disciplines credited toward degrees in occupational programs; interdisciplinary courses (including environmental sciences) covering physical sciences only, or physical sciences plus social sciences or humanities, but excluding life sciences.

Field III: Engineering and Technology

Include all courses leading to engineering degrees, except those that clearly are identical to, or that overlap with, courses offered by mathematics departments; all degree-credit courses in technologies that are not commonly considered vocational trades; courses that lead to degrees in all fields of engineering and engineering support; all degree courses in technical curricula not necessarily called engineering, such as fire science.

Field IV: Mathematics and Computer Sciences

Include mathematics courses in the traditional sequence subsequent to arithmetic, to first-year algebra, and to the first course in geometry (i.e., intermediate or second-year algebra, solid and coordinate geometry, and more advanced courses).

Exclude all arithmetic and remedial courses, first-year algebra, the first course in geometry, and other courses that are not consistently credited toward degrees; courses in shop arithmetic and technical courses limited to content from first-year algebra or the first course in geometry; all courses offered exclusively in vocational trade curricula.

Include math for nonscience students, math for liberal arts, and math understanding courses tailored to special audiences.

Include probability and statistics; business math that clearly is more advanced than arithmetic and first-year algebra; computer theory and practice courses that are offered in computer science or engineering departments, including advanced programming or scientific programming and excluding programming designed strictly for business applications.

Exclude keypunch and elementary programming, and computer programming taught in schools of business unless designed for applications other than business.

Field V: Social Sciences

Include anthropology, economics (including economics offered in business schools if generally equivalent to arts and sciences courses), geography, government, political sciences, police science, sociology, and psychology (except for clinical practice in special education or education methods courses).

3. BACKGROUND CHARACTERISTICS OF STUDY POPULATIONS

3.1 Overview

As discussed in Section 2.1, this study involved three populations: institutions, faculty, and students. Their background characteristics are described in this chapter. The size of institutions, their sources of control, and the types of science programs offered in two-year colleges were covered in Section 2.1. This section focuses on institutional affiliation and regional differences. Science faculty are analyzed not only by types of colleges but also by the educational fields in which they teach. Characteristics of faculty discussed in this chapter include sex, age, employment status, educational qualifications, and work load. The discussion of students involves such issues as who enrolls in two-year college science programs and for what reasons and covers sex, age, race or ethnic background, and attendance status (full- or part-time). Students also are analyzed both by the types of colleges they attend and the educational fields in which they are taking classes.

3.2 Institutions That Offer Science Education

The two-year colleges included in this study may be characterized in several ways: according to size of enrollment, type of educational programs offered, control (public or private), geographic region, and affiliation with other college campuses as parts of systems. In Section 2.2 (Sample Design) we described the distribution of college sizes and the relative proportions of private colleges, technical institutes, and public comprehensive colleges. In this section we examine regional characteristics and affiliation in more detail.

3.2.1 Regional Distribution

Geographically, the country may be divided into four large regions, with the following distribution of two-year colleges:

East	17 percent
South	32 percent
Midwest	31 percent
West	20 percent

California has more two-year colleges than any other state, with more than nine percent of all colleges in the AACJC listing. Texas is next, with nearly six percent, followed by North Carolina (5 percent). The distribution of two-year colleges across the country is by no means even, nor it is necessarily proportionate to the population of the states. Development of two-year colleges has been highly variable.

A number of institutional characteristics are strongly related to geographical location as a result of the variety of ways in which two-year college systems have developed in different states and regions. California, for example, has a preponderance of large colleges. In our sample, 38 percent of the large comprehensive colleges were in California, although that state has only 9 percent of all two-year colleges. More private colleges are to be found in eastern states than would be expected if the distribution was homogeneous. Private colleges are almost invariably quite small. Technical institutes are concentrated very disproportionately in the southern states. About 50 percent of all technical institutes appearing on a list of such colleges supplied by AACJC were in the south; only 8 percent were in the west. It is clear that institutional characteristics vary among regions, making it difficult to draw comprehensive and meaningful conclusions on the basis of geography alone. For this reason, no further analysis is presented by geographic region.

3.2.2 Affiliation

Another general characteristic of two-year colleges is how they are organized as components or campuses of college systems. Four categories of affiliation for campuses of public institutions can be identified, with a fifth category to account for private colleges. In Table 3-1 the five types of colleges are cross classified by type of affiliation. Data were supplied by college administrators on the institutional questionnaire.

More than half of all public two-year colleges are components of state systems with varying degrees of autonomy within these systems, depending on the states. Local or regional multicampus systems constitute 19 percent of the public college campuses; these systems have their own central administration units that coordinate activities, with each campus having some degree of autonomy. Considerable variation exists among campuses in size, facilities, and even academic emphases. These multi-campus systems themselves, however, are sometimes part of state systems. They have not been grouped with state systems in Table 3-1 because of their uniqueness, but in terms of state control the percent of campuses under state systems actually exceeds the 56 percent shown in the table. As has been noted, our survey used the individual campus of multicampus systems as the unit for determining the college sample.

University systems with two-year college components are another form of central state control, although in a few cases private universities have two-year college components. This kind of structure is a result of historical trends in individual states. One by-product is the inclusion of a large percentage of technical institutes as parts of state university systems, since in those states with a large network of technically oriented institutions, either the state university or a technical college

Table 3-1. Percent distribution of two-year colleges affil
of affiliation and type of college

Affiliation	Type of college*			
	Private colleges	Technical institutes	Small compre-hensive	M co he
State system of two-year colleges	-	51	41	
University system	6	37	20	
Local or regional multicampus system	0	8	25	
Unaffiliated campus (public)	-	1	14	
Private independent	94	2	-	

*College types are defined in Section 2.5.

Note: Column sum may not total 100 because of rounding.

system has been given jurisdiction. In at least one state both systems coexist.

Given the diversity of state patterns, no analyses have been presented by type of affiliation, since they would reflect political organization more than distinctive two-year college characteristics. As with geographic region, more meaningful differences appear among two-year colleges when they are classified according to the five types of college already described.

3.3 Two-Year College Faculty in Science Education

Who teaches science in two-year colleges? Are there more men than women faculty members? What are their qualifications? What proportion of the faculty members is full-time? These questions are of interest because the quality of science education that students receive in two-year colleges obviously depends in part on the qualifications of the instructors. This section presents data that help to answer these questions. The data also provide a basis for assessing manpower resources in science education in two-year colleges.

3.3.1 Number of Faculty Members

It is estimated that more than 64,000 individuals were teaching science courses in two-year colleges in Spring 1979. About one-quarter of them were in the social sciences. There were about equal numbers of faculty in the health sciences, other life sciences, physical sciences, and engineering and technology. Each of these fields has more than 9,000 faculty members (see Table 3-2).

Table 3-2. Percent distribution of faculty, by educational field and full-/part-time status

Status	Educational field								Total
	Introductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathematics	Computer sciences	Social sciences	
Full-time	77	83	91	67	51	67	77	70	69
Part-time	23	17	9	33	49	33	23	30	31
Total									
Number	2,311	9,756	9,517	9,937	9,438	6,311	703	16,309	64,282
Percent[1]	4	15	15	15	15	10	1	25	100

[1]Percentages across educational fields.

The number of faculty in mathematics may be underestimated because the sample may have excluded many of those faculty members teaching math courses not credited toward associate degrees (e.g., high school algebra, remedial arithmetic) or teaching courses tailored to vocational trade programs. The study sample only drew courses that are credited toward the associate degree. In addition, faculty members in computer-oriented courses are analyzed separately from the math faculty. Computer faculty are drawn from both math and technology departments, as well as from departments of computer science where they exist. However, the faculty members surveyed in this study are by no means representative of all those who teach courses in computer applications, since courses offered by business departments were excluded, along with courses focusing on computer applications to business. Keypunching was not included either.

The majority of the science faculty members is teaching in comprehensive colleges. As shown in Table 3-3, about 80 percent of the total faculty are in comprehensive colleges. This high percentage is predictable, since about 75 percent of the two-year colleges are comprehensive schools and are generally large in size.

Of these science faculty members, about 72 percent are men and 28 percent women; 69 percent teach full-time and 31 percent part-time. As expected, these breakdowns vary by type of school and field. Further details are presented in the following subsections.

3.3.2 Full-Time/Part-time Status

The distributions of full-time and part-time faculty members by fields of science and by types of schools are presented

Table 3-3. Percent distribution of faculty, by type of college and full-/part-time status

Status	Type of college					Total
	Technical institutes	Private colleges	Small compre-hensive	Medium compre-hensive	Large compre-hensive	
Full-time	74	67	79	66	68	69
Part-time	26	33	21	34	32	31
Total						
Number	9,864	3,252	5,771	22,877	22,518	64,782
Percent*	15	5	9	36	35	100

*Percentages across types of institutions.

in Tables 3-2 and 3-3. Table 3-2 shows that there are proportionately more full-time faculty teaching courses in the health sciences and other life sciences than in other fields. Almost half of the engineering and technology sections are taught by part-time teachers. Part-time faculty members teach about one-third of the mathematics, physical sciences, and social sciences courses.

Proportionately more full-time faculty teach in small comprehensive colleges and technical institutes than in other types of colleges, as Table 3-3 indicates.

3.3.3 Distribution of Faculty by Sex and Age

As mentioned above, there are more men than women faculty members in all sciences except the health sciences. As shown in Table 3-4, 70 percent of full-time faculty are men. The percentage is even higher in the physical sciences, engineering and technology, and computer sciences. The percentages for these fields are 92, 98, and 96, respectively. The high proportion of male faculty in science disciplines is not unexpected because these fields traditionally have been male dominated. In the health fields, there are more women faculty than men (87 and 13 percent, respectively). Part-time faculty in general follows the same proportions of more men than women except in mathematics and introductory biology, where the reverse is true (see Table 3-4).

The proportions of men and women faculty do not vary significantly among types of institutions. Except for technical institutes, the ratio of men to women is about 7 to 3 for full-time faculty. The part-time faculty, however, shows a somewhat different pattern. There are almost as many part-time women faculty members as men in private colleges and small comprehensive schools (see Table 3-5).

Table 3-4. Percent distribution of faculty, by sex, educational field, and full-/part-time status

Status and sex	Educational field								Total
	Intro-ductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathe-matics	Computer sciences	Social sciences	
Full-time									
Men	67	13	78	92	98	79	96	79	70
Women	33	87	22	8	2	21	4	21	30
Part-time									
Men	27	17	86	84	97	49	64	79	75
Women	73	83	14	16	3	51	36	21	25
Total									
Men	58	14	78	89	97	69	88	79	72
Women	42	86	22	11	3	31	12	21	28

Table 3-5. Percent distribution of faculty, by sex, type of college, and full-/part-time status

Status and sex	Type of college				
	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive
Full-time					
Men	59	74	74	74	71
Women	41	26	26	26	29
Part-time					
Men	87	55	52	85	65
Women	13	45	48	15	35
Total					
Men	66	68	70	78	69
Women	34	32	30	22	31

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Age distribution shows that a majority of faculty (both full- and part-time) are 30 to 49 years old (see Table 3-6). It is important to note that there are more women than men under age 30, both full-time and part-time. This finding could reflect either the trend that more women have entered science fields in recent years, or that affirmative action has increased the hiring of women faculty. Part-time faculty members are younger than full-time faculty. As shown in Table 3-6, the percentage of part-time faculty under age 30 is 25, as compared to 10 percent of full-time faculty.

Faculty age distribution by type of school and by educational field also was examined. Results show that there are proportionately more young full-time faculty (under 30) in technical institutes and private colleges than in other types of schools, and that there are more young part-time faculty in small comprehensive schools than in other types (see Table 3-7). By educational fields, there is a considerably higher percentage of full-time faculty under 30 teaching introductory biology (28 percent) than teaching in other fields (see Table 3-8). About 40 percent of part-time faculty in the health sciences is under the age of 30. In contrast, a substantial percentage of part-time faculty teaching other life sciences courses is 60 years or older (28 percent). Reasons for these differences are not clear.

3.3.4 Faculty Academic Qualifications and Years of Teaching Experience

Table 3-9 shows that about 80 percent of full-time faculty and 70 percent of part-time faculty in the sciences have graduate degrees -- masters or doctorates. The physical sciences have the highest proportion of faculty members with doctorate degrees among the eight science fields; 38 percent of

Table 3-6. Percent distribution of faculty, by age, full-/part-time status, and sex

Age	Full-time		Part-time		Total			
	Men	Women	Men	Women	Men	Women	Full-time	Part-time
≤ 25	1	3	7	6	3	4	1	7
26-29	6	16	17	22	10	18	9	18
30-39	37	31	34	39	36	33	36	36
40-49	33	36	21	26	29	33	34	22
50-59	20	11	15	7	18	10	17	13
≥ 60	4	3	6	0	4	2	3	5

Note: Column sum may not total 100 because of rounding.

Table 3-7. Percent distribution of faculty, by age, full-/part-time status, and type of college

Age	Type of college and status									
	Full-time					Part-time				
	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive
≤ 25	1	11	0	2	1	11	0	21	4	7
26-29	19	16	11	6	6	21	0	24	17	21
30-39	36	23	48	38	31	36	46	0	41	34
40-49	30	24	18	37	39	21	20	55	22	16
50-59	14	20	15	15	21	13	23	0	14	12
≥ 60	2	6	8	3	3	0	12	0	2	9

Note: Column sum may not total 100 because of rounding.

Table 3-8. Percent distribution of faculty, by age, full-/part-time status, and educational field

Age	Educational field and status															
	Introductory biology		Health sciences		Other life sciences		Physical sciences		Engineering and technology		Mathematics		Computer sciences		Social sciences	
	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
≤ 25	14	0	2	10	0	0	1	9	1	13	2	5	0	0	1	3
26-29	14	18	13	30	17	31	3	17	3	12	9	[illegible]	13	0	5	24
30-39	30	27	29	33	37	15	35	24	27	26	47	57	34	64	40	46
40-49	26	0	41	26	31	13	44	33	29	23	28	25	49	37	30	15
50-59	16	55	15	0	12	13	14	11	31	23	12	10	4	0	19	7
≥ 60	0	0	0	0	2	28	3	6	8	3	2	0	0	0	6	5

Note: Column sum may not total 100 because of rounding.

Table 3-9. Percent distribution of faculty, by highest degree, educational field, and full-/part-time status

Degree and status	Educational field								Total	
	Introductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathematics	Computer sciences	Social sciences	Number	Percent
Full-time										
No degree	0	5	1	1	7	3	0	6	1,530	3
Associate	0	3	1	1	4	0	6	0	663	1
Bachelors	0	39	14	2	32	4	24	4	6,718	15
Masters	77	50	61	58	47	83	70	69	27,479	62
Doctorate	23	3	24	38	10	10	0	21	8,221	18
Total number	1,806	8,092	8,621	6,614	4,833	4,207	541	9,897	44,612*	100
Part-time										
No degree	0	0	0	0	17	0	37	2	956	5
Associate	0	0	42	4	13	0	0	0	1,088	6
Bachelors	0	25	[illegible]	18	43	11	0	14	4,058	21
Masters	100	60	31	52	28	87	64	57	10,310	53
Doctorate	0	15	27	26	0	2	0	28	3,173	16
Total number	505	1,664	896	3,323	4,579	2,044	162	6,412	19,585*	100

*Total numbers do not add to 64,232 because of nonresponse.

the full-time faculty and 26 percent of the part-time faculty hold doctorate degrees. In the health sciences, engineering and technology, and computer sciences, there are substantial percentages of faculty with bachelors degrees.

These graduate degrees are subject matter degrees. Only 14 percent of the masters degrees and 18 percent of the doctorates are in education. Table 3-10 shows the percent of masters and doctorate degrees in education, by field. It should be noted that graduate degrees in education also may be subject matter oriented, as is the case with the masters degree in science education and doctorate degree in math education.

By types of institutions, large comprehensive colleges have a greater percentage of faculty with doctorate degrees than do other types of schools. The majority of faculty among all types of institutions, as among all educational fields, hold masters degrees (see Table 3-11).

A majority of the faculty members in the sciences has extensive teaching experience. For full-time faculty, the average number of years of teaching is 14 for men and 10 for women. The average number of years of teaching experience for part-time faculty is eight for both men and women (see Table 3-12). As one would expect, most faculty members' experience was gained in two-year colleges. However, in some fields a significant number of teachers had precollege teaching experience before becoming two-year college faculty members. Many of these teachers are in mathematics and introductory biology, where the full-time faculty averages 3.2 and 4.3 years of high school teaching, respectively. Part-time faculty members in mathematics, introductory biology, and physical sciences also have had fairly extensive high school teaching experience particularly those in mathematics, who average nearly seven years of high school instruction (see Table 3-13).

Table 3-10. Percent distribution of faculty with graduate degrees in education rather than in subject matter fields, by educational field and type of degree

Educational field	Graduate degrees in education	
	Masters	Doctorate
Introductory biology	1	12
Health sciences	30	50
Other life sciences	10	12
Physical sciences	11	14
Engineering and technology	22	14
Mathematics	17	28
Computer sciences	13	0
Social sciences	10	20
All faculty	14	18

Table 3-11. Percent distribution of faculty, by highest degree, type of college, and full-/part-time status

Degree and status	Type of college					Total	
	Technical institutes	Private colleges	Small compre-hensive	Medium compre-hensive	Large compre-hensive	Number	Percent
Full-time							
No degree	4	0	3	3	4	1,530	3
Associate	6	0	1	1	1	663	1
Bachelors	23	16	7	16	13	6,718	15
Masters	56	71	72	65	57	27,479	62
Doctorate	11	14	17	16	26	8,221	18
Total number	7,264	2,181	4,582	15,174	15,410	44,612*	100
Part-time							
No degree	13	0	0	4	5	956	5
Associate	2	0	0	5	9	1,088	6
Bachelors	43	4	36	17	16	4,058	21
Masters	39	74	64	56	50	10,310	53
Doctorate	3	22	0	19	20	3,173	16
Total number	2,600	1,070	1,163	7,645	7,108	19,585*	100

*Total numbers do not add to 64,282 because of nonresponse.

Table 3-12. Faculty members' average years of teaching, by sex and full-/part-time status

Status	Years	
	Men	Women
Full-time	14	10
Part-time	8	8

Table 3-13. Faculty members' average years of full-time high school teaching experience, by educational field and full-/part-time status

Educational field	Status and years	
	Full-time	Part-time
Introductory biology	4.3	3.3
Health sciences	1.3	0.0
Other life sciences	2.2	0.0
Physical sciences	1.8	2.8
Engineering and technology	1.8	0.4
Mathematics	3.2	6.7
Computer sciences	0.5	0.8
Social sciences	1.3	0.3
All faculty	1.9	1.4

One question to be considered is whether faculty members teach courses in the fields in which they hold degrees. As shown in Tables 3-14 to 3-16, faculty members in two-year colleges are committed to teaching in their own fields. For example, all individuals with doctorate degrees in math are teaching math courses, and all individuals with doctorate degrees in social sciences are teaching courses in that field. However, some faculty members teach classes in related fields. For example, a large number of individuals with training in technology teach life sciences courses that probably relate to technology in life sciences. It should be noted, however, that although faculty members may teach in their minor fields, the data do not allow for the distinction between major and minor fields.

3.3.5 Teaching and Other Professional Activities

Faculty members in two-year colleges have rather heavy work loads. Based on faculty respondents' estimates, full-time faculty members work an average of 46 hours per week, while part-time faculty average 20 hours per week (see Table 3-17). As expected, most of their time is devoted to classroom teaching, which includes laboratories and class preparation. Both full-time and part-time faculty engage very infrequently in research and development. The allocation of faculty time is rather consistent across different types of institutions (see Table 3-18).

About 20 percent of full-time faculty members teach courses as overload. Overload credits average 0.7 for full-time faculty. The average overload is about 8 to 9 hours per week. This overload represents about six percent of all credit hours taught. As shown in Table 3-19, full-time faculty carry a regular teaching load of 10.7 credit hours, on the average. The range is from 8.9 credit hours for the health sciences to 14.6 hours for

Table 3-14. Percent distribution of faculty members with doctorate degrees, by major field and educational field in which they teach

Major	Educational field							
	Intro-ductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathe-matics	Computer sciences	Social sciences
General sciences	0	0	0	0	52	48	0	0
Health sciences	0	51	49	0	0	0	0	0
Other life sciences	6	0	77	14	3	0	0	0
Physical sciences	0	0	3	89	3	3	0	2
Engineering and technology	28	0	34	23	15	0	0	0
Mathematics	0	0	0	0	0	100	0	0
Computer sciences	0	0	0	0	0	0	0	0
Social sciences	0	0	0	0	0	0	0	100
Education	3	13	13	24	3	7	0	38
Nonscience field	0	0	5	0	4	0	0	91

Note: Row sum may not total 100 because of rounding.

Table 3-15. Percent distribution of faculty members with masters degrees, by major field and educational field in which they teach

Major	Educational field							
	Intro-ductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathe-matics	Computer sciences	Social sciences
General sciences	0	0	8	66	14	12	0	0
Health sciences	0	90	6	0	2	0	0	2
Other life sciences	22	1	68	7	1	1	0	0
Physical sciences	0	0	5	85	6	3	0	2
Engineering and technology	6	7	18	6	47	15	2	0
Mathematics	0	0	0	6	3	85	5	2
Computer sciences	0	0	0	0	0	0	100	0
Social sciences	0	1	0	1	1	1	0	97
Education	4	24	11	14	13	14	1	19
Nonscience field	0	0	1	2	7	2	3	85

Note: Row sum may not total 100 because of rounding.

Table 3-16. Percent distribution of faculty members with bachelor degrees, by major field and educational field in which they teach

Major	Educational field							
	Introductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathematics	Computer sciences	Social sciences
General sciences	5	12	19	18	18	7	0	23
Health sciences	0	88	11	1	0	0	0	2
Other life sciences	16	9	63	7	4	2	0	1
Physical sciences	0	0	6	81	7	5	0	1
Engineering and technology	4	5	10	7	61	8	3	2
Mathematics	0	0	0	21	4	71	2	1
Computer sciences	0	0	0	0	0	0	100	0
Social sciences	0	5	0	6	1	1	1	87
Education	10	11	4	9	27	13	1	25
Nonscience field	0	0	7	3	12	6	5	69

Note: Row sum may not total 100 because of rounding.

Table 3-17. Faculty professional activities related to college position, by type of activity, educational field and full-/part-time status (average hours spent per week)

Educational field and status	Activity: Classroom teaching	Administrative duties	R&D	Professional reading	Other activities	Total average hours
Full-time						
Introductory biology	33	2	1	3	2	41
Health sciences	28	7	2	3	2	42
Other life sciences	30	7	2	4	3	46
Physical sciences	32	4	2	4	3	45
Engineering and technology	33	6	2	4	3	48
Mathematics	34	5	1	2	2	44
Computer sciences	36	5	2	4	3	50
Social sciences	32	5	1	6	3	47
All faculty	31	6	2	4	3	46
Part-time						
Introductory biology	20	1	0	3	2	26
Health sciences	17	2	1	2	1	23
Other life sciences	13	2	0	3	1	19
Physical sciences	12	3	0	2	1	18
Engineering and technology	13	1	2	2	0	19
Mathematics	12	0	0	1	0	14
Computer sciences	18	2	0	2	5	27
Social sciences	13	3	1	2	3	22
All faculty	13	2	1	2	2	20

Table 3-18. Faculty professional activities related to college position, by type of activity, type of college, and full-/part-time status (average hours spent per week)

Type of college and status	Activity: Classroom teaching	Activity: Administrative duties	Activity: R&D	Activity: Professional reading	Activity: Other activities	Total average hours
Full-time						
Technical institutes	32	5	2	3	4	46
Private colleges	31	4	2	4	2	43
Small comprehensive	30	3	1	4	2	40
Medium comprehensive	33	5	1	4	2	45
Large comprehensive	30	7	2	5	3	47
All faculty	31	6	2	4	3	46
Part-time						
Technical institutes	15	2	4	1	4	26
Private colleges	16	13	1	4	5	39
Small comprehensive	16	0	0	4	1	21
Medium comprehensive	14	2	0	2	1	19
Large comprehensive	11	0	0	2	1	14
All faculty	13	2	1	2	2	20

Table 3-19. Faculty teaching load: average number of credit hours taught, by type of college, educational field, and full-/part-time status

	Average credit hours and status	
	Full-time	Part-time
Type of college		
Technical institutes	10.8	4.6
Private colleges	8.3	5.4
Small comprehensive	11.0	6.2
Medium comprehensive	12.2	4.9
Large comprehensive	9.4	4.4
All faculty	10.7	4.8
Educational field		
Introductory biology	9.7	6.5
Health sciences	8.9	5.2
Other life sciences	9.4	4.3
Physical sciences	10.7	4.7
Engineering and technology	11.8	4.9
Mathematics	12.9	5.1
Computer sciences	14.6	6.4
Social sciences	11.8	4.5
All faculty	10.7	4.8

computer sciences. By type of college, medium comprehensive schools have the highest average credit hour load with 12.2, and private colleges have the lowest with 8.3. Average credit hours for part-time faculty are 4.8.

Many faculty members engage in professional activities that are not a function of their positions at their colleges. The average hours per week spent on these activities are presented in Tables 3-20 and 3-21 by educational field and college type. As would be expected, these extracurricular activities are different for full- and part-time faculty. The activities to which part-time faculty members devote the most time include paid employment or consultation in other places, self-employment, and working toward advanced degrees. The full-time faculty spend their extracurricular time mostly on self-employment activities.

3.3.6 Other College Positions Held by Faculty

Twenty-two percent of the men and 11 percent of the women teaching full-time in the sciences are also department chairpersons, as Table 3-22 indicates. While only 1 percent are deans, 13 percent are other types of administrators. While these persons are designated full-time faculty, they are assigned compensatory time that frees them from a full teaching load.

Part-time faculty sometimes are drawn from the full-time college administrative staff. Five percent of these part-time teachers are men serving as department chairpersons, and six percent are women serving as deans or associate/assistant deans. A total of eight percent of all part-time faculty hold administrative posts. As Table 3-18 shows, part-time faculty in private colleges spend one-third of their full work week on administrative duties, a finding which indicates that much of the

Table 3-20. Faculty extracurricular professional activities, by type of activity, educational field, and full-/part-time status (average hours spent per week)

Educational field and status	Activity										Total average hours
	Adjunct teaching (this college)	Teaching another institution: 2-year	Teaching another institution: 4-year	Teaching another institution: High school	Working toward advanced degree	Research other than for advanced degree	Paid employment or consultation	Self-employment	Activities in professional associations	Other professional activities	
Full-time											
Introductory biology	0	0	0	0	0	0	0	0	0	1	1
Health sciences	0	0	0	0	0	0	1	1	2	1	5
Other life sciences	1	0	0	0	1	0	1	2	1	1	7
Physical sciences	1	0	0	0	0	0	1	1	1	1	5
Engineering and technology	1	0	0	0	1	0	1	4	1	1	9
Mathematics	1	0	0	0	1	0	0	1	0	0	3
Computer sciences	2	0	0	0	1	0	2	3	1	0	9
Social sciences	1	0	0	0	2	0	1	2	1	1	8
All faculty	1	0	0	0	1	0	1	2	1	1	7
Part-time											
Introductory biology	0	0	0	0	2	1	0	4	0	0	5
Health sciences	0	0	0	0	2	0	14	5	1	0	26
Other life sciences	0	0	2	0	0	0	12	0	1	0	16
Physical sciences		0	5	4	12	0	7	3	0	0	31
Engineering and technology	1	0	0	1	2	0	22	6	1	1	35
Mathematics		3	1	12	0	0	6	2	0	0	28
Computer sciences	2	0	0	0	1	0	18	1	1	0	24
Social sciences	0	0	2	0	4	1	9	4	1	2	25
All faculty	1	1	2	2	4	0	12	4	1	1	28

Table 3-21. Faculty extracurricular professional activities, by type of activity, type of college, and full-/part-time status (average hours spent per week)

Type of college and status	Activity										Total average hours
	Adjunct teaching (this college)	Teaching at another institution			Working toward advanced degree	Research other than for advanced degree	Paid employment or consultation	Self-employment	Activities in professional associations	Other professional activities	
		2-year	4-year	High school							
Full-time											
Technical institutes	1	0	0	0	0	0	0	2	1	1	6
Private colleges	1	0	0	0	1	0	0	0	1	0	4
Small comprehensive	0	0	0	0	0	0	0	1	1	1	3
Medium comprehensive	0	0	0	0	1	0	1	2	1	1	6
Large comprehensive	1	0	0	0	2	0	1	2	1	1	8
All faculty	1	0	0	0	1	0	1	2	1	1	7
Part-time											
Technical institutes	0	0	2	4	6	0	9	2	1	1	28
Private colleges	2	4	1	1	0	0	3	2	0	2	13
Small comprehensive	0	0	0	2	3	0	3	3	0	0	17
Medium comprehensive	1	0	2	2	6	0	13	3	1	0	30
Large comprehensive	0	1	2	2	3	1	15	6	1	2	31
All faculty	1	1	2	2	4	0	12	4	1	1	28

Table 3-22. Percent distribution of teaching faculty holding administrative positions, by type of position, sex, and full-/part-time status

Position	Male	Female	Total
Full-time			
Department or div sion chairperson	22	11	18
Dean or associate/assistant dean	1	0	1
Other type of administrator	12	16	13
Counselor	6	11	7
No other position held	58	56	57
Other	8	17	10
Part-time			
Department or division chairperson	5	0	3
Dean or associate/assistant dean	0	6	1
Other type of administrator	5	1	4
Counselor	5	0	4
No other position held	85	93	87
Other	6	1	5

Note: Percents add to more than 100 because of multiple positions held by some faculty members.

part-time teaching in private colleges is performed by chairpersons and others in administrative positions.

3.4 Two-Year College Students in Science Education

This section presents an overview of student characteristics, such as sex, age, race, educational background, and educational plans, as well as enrollment status (e.g., full- or part-time). This background information should enhance understanding of the types of students who choose to enroll in science classes in two-year colleges and should assist policymakers in developing programs to meet the educational needs of students in these colleges.

Readers are reminded that the students described in this section are representative only of those taking science courses in the two-year colleges surveyed in this study. They do not necessarily represent the two-year college student population as a whole. No previous studies using designs compatible with this one were available; thus, the data presented in this section are rather unique. It may be assumed that students in science programs differ somewhat from students in nonscience programs. To verify this assumption, comparisons of the characteristics of students in science classes and the student population as a whole have been made whenever reliable data were available.

Students usually take science courses either because they intend to major in science or because there are general education requirements for courses in mathematics, social science, or the natural sciences. Most natural science classes are introductory or "service" courses. The characteristics of students in these courses are of particular interest to this study. In the life sciences, it was possible to isolate a sufficiently large number of classes to permit separate analysis of those taking introductory biology. However, course offerings in other fields also consist largely of introductory classes. Thus, a major portion of two-year college students in many of the educational fields are enrolled in introductory courses.

3.4.1 Distribution of Students by Full-/Part-Time Status and by Sex

On the basis of the data gathered in this study, it is estimated that about 1.3 million students are taking one or more science courses in two-year colleges. About 85 percent of those students are enrolled in comprehensive schools, 9 percent in technical institutes, and 6 percent in private colleges. By educational field, about 65 percent of those students are taking one or more courses in social sciences. About an equal number of students are enrolled in physical science and engineering and technology courses (i.e., each about a quarter million). Detailed numbers and percents are shown in Table 3-23, by college type and educational field.

The number of students in mathematics reported in this study may not correspond with estimates from other studies. Only students taking courses that normally are credited toward two-year college degrees were included in this sample. This procedure eliminated students enrolled in remedial arithmetic and basic high school courses. In addition, students taking classes in computer operations were separated from mathematics students for purposes of analysis. The only computer science students included were those taking courses given by departments of mathematics, technologies, engineering, or computer sciences. Excluded were business-oriented courses.

able 3-23. Percent distribution and number of science students, by type of college, educational field, sex, and full-/part-time status

College type and educational field	Number of students in sample	Weighted number of students	Sex (percent)		Status (percent)	
			Men	Women	Full-time	Part-time
ype of college						
Technical institutes	506	117,981	57	43	82	18
Private colleges	155	86,167	29	71	92	8
Small comprehensive	263	117,526	44	56	65	35
Medium comprehensive	1,195	491,267	44	56	72	28
Large comprehensive	1,119	488,143	53	47	56	44
Total	3,238	1,301,160	47.5	52.5	68	32
ducational field						
Introductory biology	87	32,884	42	58	80	20
Health sciences	248	108,292	14	86	79	21
Other life sciences	398	153,001	26	74	78	22
Physical sciences	641	254,539	62	38	80	20
Engineering and technology	671	248,202	82	18	72	28
Mathematics	562	157,730	59	41	76	24
Computer sciences	82	20,550	56	44	72	28
Social sciences	549	852,169	44	56	69	31
Total	3,238	1,301,160*	47.5	52.5	68	32

Total is not the sum of individual column entries because some students take course in more than one field. The correct total is the same as that for college types, which represents no overlap.

Of all students taking science courses, there are more women than men. However, the percentages vary by field and type of school. As shown in Table 3-23, substantially more women than men are enrolled in introductory biology, health sciences, other life sciences, and social sciences. However, more men than women take courses in the physical sciences, engineering and technology, mathematics, and computer sciences. The most striking difference is between health sciences and engineering and technology. The health science classes include 86 percent women, while courses in engineering and technologies enroll 82 percent men.

The influence of social science students on combined student statistics should be kept in mind here. Forty-seven percent of all students in all science fields are in social science classes. Without the social sciences, the overall proportion of men in science classes would be greater than that of women.

By types of colleges, the data show that most (71 percent) of the private college students are women, and a majority of the students in technical institutes (57 percent) is men. Whereas both small and medium comprehensive schools have 56 percent women students, the large comprehensive colleges have 53 percent men students.

Students taking science courses represent about 31 percent of all two-year college students (see Table 3-24). The proportions of men and women taking science courses in two-year colleges are nearly equal, but slightly favor women. However, the percentage of full-time students enrolled in science classes is far greater than that of part-time students -- 55 percent compared to 17 percent.

Table 3-24. Percent distribution and numbers of all two-year college students and science students by sex and full-/part-time status

Students	Male		Female		Total				Total, all groups
					Sex		Status		
	Full-time	Part-time	Full-time	Part-time	Male	Female	Full-time	Part-time	
All two-year college students*									
Number	806,833	1,197,260	801,266	1,337,153	2,004,093	2,138,419	1,608,099	2,534,413	4,142,512
Percent	19.5	28.9	19.3	32.3	48.4	51.6	38.8	61.2	
Science students**									
Number	428,082	189,969	452,804	230,305	618,051	683,109	880,885	420,275	1,301,160
Percent	32.9	14.6	34.8	17.7	47.5	52.5	67.7	32.3	
Percent of all college students enrolled in science courses	53.1	15.9	56.5	17.2	30.8	31.9	54.8	16.6	31.4

*From 1979 Community, Junior College, and Technical College Directory, American Association of Community and Junior Colleges, p. 2. (Response: 4,142,512 out of 4,304,058 students.)

**Data from this study, all students combined.

This last finding accentuates a major difference between the population of all two-year college students and those who take science. Whereas 61 percent of all students attend part-time, only 32 percent of those taking science courses attend part-time. Data for both men and women show this sharp difference.

As shown in Table 3-23, the percentages of part-time students range from 31 percent in the social sciences to 20 percent in the physical sciences and introductory biology. By type of college, the percentages of part-time students vary from 8 percent in private colleges to 44 percent in large comprehensive schools.

3.4.2 Distribution of Students by Age

Table 3-25 presents the age distribution of students taking science courses, cross classified by sex and enrollment status. Students younger than 18 constitute about two percent of all science students; they are likely to be high school students taking college level courses part-time. At the other end of the age distribution, about .3 percent of the students are age 60 or over; most are studying part-time. Overall, the median age is about 22.

There is a substantial difference in median age between full- and part-time students in science courses (21 and 28, respectively). This difference is even greater among women students, as indicated by a median age of 21 for full-time women students and 31 for part-time women students. It is interesting to note that about 43 percent of part-time women students are 30 to 44 years old.

9.

Table 3-25. Percent distribution of science students, by age, sex, and full-/part-time status

Age	Male		Female		Total				Total, all groups
					Sex		Status		
	Full-time	Part-time	Full-time	Part-time	Male	Female	Full-time	Part-time	
< 18	1.1	4.3	0.9	2.8	2.1	1.6	1.0	3.5	1.8
18-19	36.0	7.6	35.8	8.3	27.3	26.5	35.9	7.9	26.9
20-21	26.8	7.5	22.3	8.4	20.9	17.6	24.5	8.0	19.2
22-25	20.4	24.7	17.1	15.9	21.7	16.7	18.7	19.9	19.1
26-29	6.3	20.6	8.9	11.4	10.7	9.7	7.6	15.6	10.2
30-44	6.8	28.8	13.1	42.7	13.6	23.1	10.1	36.4	18.6
45-49	2.5	6.6	1.7	9.9	3.4	4.4	2.0	7.9	3.9
≥ 60	0.0	0.9	0.2	0.6	0.3	0.3	0.1	0.7	0.3
Median age	20.5	26.6	20.7	30.6	21.5	22.5	20.6	28.2	21.9

Note: Column sums may not total 100 because of rounding.

The age distribution of students also varies by educational fields and types of colleges. As shown in Table 3-26, students in introductory biology classes are on the average the youngest, while students in health sciences are the oldest. By college types, the median age of students is lowest in technical institutes and highest in large comprehensive schools (see Table 3-27). Further examination of the data reveals that students over 60 almost exclusively are enrolled in medium and large comprehensive colleges (the percentages are 46 and 50, respectively). They are more likely to study physical science (50 percent) and social science (27 percent).

3.4.3 Distribution of Students by Race

The majority of science students in two-year colleges is white (83 percent). The next largest group is black (8 percent). Asians or Pacific Islanders and Hispanics constitute about four and three percent, respectively. American Indians or Alaskan Natives make up only about two percent of the science students (see Table 3-28). This composition is the same for full- and part-time students.

The proportion of women students varies among racial groups. As shown in Table 3-28, there are proportionately more black women than black men students, while the opposite is true for Asians and Native Americans. Whites and Hispanics are represented by about equal numbers of men and women. Further examination of the data reveals that the majority of black women are studying full-time.

The racial distribution of science students differs from that of all students in two-year colleges. According to the 1978 annual survey by the AACJC, the percentages of two-year

Table 3-26. Percent distribution of science students, by age and educational field

Age	Educational field							
	Introductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathematics	Computer sciences	Social sciences
< 18	6	0	1	1	2	2	4	2
18-19	51	15	23	32	28	34	17	30
20-21	18	16	22	22	20	25	22	18
22-25	7	32	26	18	16	19	13	18
26-29	6	13	13	11	15	9	23	8
30-44	12	22	15	14	14	9	15	19
45-59	1	2	2	2	5	2	5	5
≥ 60	0	0	0	0	0	0	0	0
Median age	19.2	23.9	22.1	21.0	21.5	20.6	23.7	21.5

Table 3-27. Percent distribution of science students, by age and type of college

Age	Type of college					Total, all colleges
	Technical institutes	Private colleges	Small compre-hensive	Medium compre-hensive	Large compre-hensive	
< 18	1	2	2	1	3	2
18-19	31	37	34	27	22	27
20-21	28	8	14	21	19	19
22-25	16	17	13	21	20	19
26-29	9	17	10	7	12	10
30-44	14	16	27	17	20	18
45-59	1	3	1	5	5	4
≥ 60	0	0	0	0	0	0.3
Median age	20.8	22.2	21.5	21.6	22.8	21.9

Table 3-28. Percent distribution of science students, by racial/ethnic group, sex, and full-/part-time status

Racial/ethnic group	Male		Female		Total				Total all groups
					Sex		Status		
	Full-time	Part-time	Full-time	Part-time	Male	Female	Full-time	Part-time	
American Indian or Alaskan Native	3.4	2.2	0.7	3.5	3.1	1.6	2.0	2.9	2.3
Asian or Pacific Islander	5.3	4.5	2.3	2.6	5.0	2.4	3.7	3.4	3.6
Black (except Hispanic)	5.8	5.5	11.7	4.3	5.7	9.2	8.8	4.8	7.5
White (except Hispanic)	81.9	85.2	81.7	87.5	82.9	83.7	81.8	86.5	83.3
Hispanic	3.6	2.7	3.6	2.1	3.3	3.1	3.6	2.3	3.2

Note: Column sums may not total 100 because of rounding.

college students, by racial/ethnic group, are as follows: 1 percent American Indians or Alaskan Natives, 3 percent Asians, 11 percent blacks, 78 percent whites, and 7 percent Hispanics. When these percentages are compared with the racial distribution of science students presented in Table 3-28, it can be seen that whites, American Indians or Alaskan Natives, and Asians or Pacific Islanders are more likely to be enrolled in science courses than are blacks and Hispanics; this distinction is particularly evident among men students. Reasons for the differences are not clear. Factors such as career aspirations, high school preparation, and cultural expectations may contribute. Further studies of these differences may be warranted.

The distribution of students by educational field and type of college varies among racial/ethnic groups. As shown in Table 3-29, about 75 percent of American Indians/Alaskan Natives, as compared to 39 percent of Hispanics, are taking social science courses. Asians are more likely than others to take courses in physical science, mathematics, and computer science. In contrast to other groups, there is a high percentage of blacks in the health sciences (16 percent, compared to 5 percent of whites), and a high percentage of Hispanics in engineering and technology (18 percent, compared to 10 percent of blacks and 14 percent of whites). The data clearly show that students of varying racial backgrounds differ in their choices of fields of study.

Table 3-29 also shows that blacks who take science courses are more likely to be enrolled in private colleges than are other groups (20 percent, compared to 6 percent for whites and less than 1 percent for Hispanics). However, it should be remembered that the majority of all students are enrolled in medium and large comprehensive schools.

able 3-29. Percent distribution of students, by racial/ethnic groups, educational field, and type of college

Field and college type	Racial/ethnic group					Total, all groups
	American Indian/ Alaskan native	Asian/ Pacific Islander	Black	White	Hispanic	
ucational field						
Introductory biology	2	2	3	2	1	2
Health sciences	1	2	16	5	8	6
Other life sciences	0	4	2	9	7	8
Physical sciences	9	17	10	14	16	14
Engineering and technology	8	12	10	14	18	14
Mathematics	4	11	9	9	9	9
Computer sciences	1	3	1	1	2	1
Social sciences	75	48	49	46	39	46
pe of college						
Technical institutes	2	2	8	10	6	9
Private colleges	0	5	20	6	0	7
Small comprehensive	2	12	10	9	5	9
Medium comprehensive	48	26	32	39	23	38
Large comprehensive	48	54	31	36	66	38

te: Column sums may not total 100 because of rounding.

3.4.4 Previous Education

As expected, the majority (98 percent) of the students has high school diplomas. Only about one percent of the students taking science courses are still high school students, and about one percent have left high school without diplomas. The high school students most frequently take courses in computer science and mathematics (see Table 3-30).

Data show that about eight percent of the science students enrolled in two-year colleges already have associate degrees and/or other college degrees. Data also show that another 28 percent previously attended colleges without obtaining degrees. About 68 percent of all students previously attending college indicated that they currently are pursuing courses of study different from those they had followed before.

Previous college attendance and change of field are most evident among students presently enrolled in health sciences, engineering and technology, mathematics, and computer sciences. For example, 22 percent of the students in computer sciences already hold college degrees, and 79 percent of those degrees are in fields different than the one currently pursued. In the health sciences, 12 percent have college degrees, with 77 percent of these degrees in other fields. These data are probably good evidence of career changes to fields holding promise of employment.

When displayed by type of college, the data show that, of the students attending technical institutes, about 40 percent have previous college experience, and 80 percent of these students have changed majors. Private colleges enroll only 26 percent who previously attended college, but 82 percent of those students have changed majors.

Table 3-30. Students' previous educational history, by type of college and educational field (percent distribution)

Type of college and field	High school diploma or equivalency	Still in high school	No diploma, not in high school	One or more college degrees	Attended college previously, no degrees	First college attended	Educational program at this college differs from that at previous colleges
Type of college							
Technical institutes	100	0	0	5	33	62	80
Private colleges	100	0	0	6	17	74	82
Small comprehensive	98	1	1	5	12	83	67
Medium comprehensive	98	1	1	7	30	63	65
Large comprehensive	96	3	1	10	29	61	66
Educational field							
Introductory biology	99	0	1	1	27	72	62
Health sciences	100	0	0	12	36	52	77
Other life sciences	99	1	0	10	31	59	71
Physical sciences	98	1	1	9	27	64	69
Engineering and technology	99	1	0	9	30	61	78
Mathematics	97	2	1	10	24	66	59
Computer sciences	94	3	3	22	30	48	79
Social sciences	96	3	1	5	26	69	63
Total	98	1	1	8	28	64	68

3.4.5 Relationship of Educational Field to College Type

The educational fields of students vary by the types of colleges in which they are enrolled. Table 3-31 shows that 29 percent of the students in technical institutes are in engineering and technology, while over half (55 percent) of the students in small comprehensive colleges are enrolled in the social sciences.

The distribution of educational fields among the college types provides a somewhat different view. In Table 3-32 it is seen that 67 percent of computer sciences students and 42 percent of the engineering and technology students are enrolled in large comprehensive institutions. The majority of students in the health sciences attend large comprehensive colleges.

3.4.6 Educational Plans and Career Goals

The students were asked about their career goals, major fields of study, purposes in attending college, reasons for enrolling in the courses covered in the survey, and reasons for choosing the colleges they attend. These areas are covered in the following analysis.

a. Major Field of Study

One indication of educational and career goals is the students' major fields of study. Table 3-33 shows the areas of science in which students are majoring, as well as selected non-science majors, and the educational fields in which they are taking courses.

ble 3-31. Percent distribution of students enrolled in each type of college, by educational field

Educational field	Type of college					Total
	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive	
troductory biology	0	8	5	2	1	2
alth sciences	12	12	3	6	8	7
her life sciences	11	16	4	13	8	10
ysical sciences	13	9	15	14	12	13
gineering and technology	29	2	7	8	14	12
thematics	7	7	10	9	9	9
mputer sciences	1	0	0	1	2	1
cial sciences	26	46	55	47	46	45
Total	100	100	100	100	100	100

te: Column sums may not total 100 because of rounding.

Table 3-32. Percent distribution of students enrolled in each educational field, by type of college

Type of college	Educational field								Total
	Intro-ductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathe-matics	Computer sciences	Social sciences	
Technical institutes	0	14	10	10	26	8	8	6	10
Private colleges	26	14	11	4	1	6	0	8	7
Small comprehensive	22	4	4	11	5	12	0	12	10
Medium comprehensive	38	30	48	40	26	37	24	38	37
Large comprehensive	14	38	28	35	42	38	67	36	36
Total	100	100	100	100	100	100	100	100	100

Note: Column sums may not total 100 because of rounding.

Table 3-33. Percent distribution of students' major fields, by type of major and educational field of course

Type of major	Educational field: Introductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathematics	Computer sciences	Social sciences	All students
Science major									
Biological sciences	6	1	10	6	1	3	2	2	3
Computer sciences	0	0	0	1	2	4	38	2	2
Engineering	0	0	0	3	5	2	4	1	2
Science (unspecified)	0	1	0	0	0	0	0	0	1
Mathematics	0	0	0	1	0	4	0	0	1
Nursing	6	47	26	6	0	2	0	12	12
Physical sciences	2	1	0	7	1	3	4	0	1
Social sciences	10	1	2	3	1	4	0	20	11
Health-related occupations	8	36	30	10	2	4	0	7	10
Technologies: mechancial & engineering	7	10	8	28	75	27	23	9	22
Agriculture	1	0	6	1	1	1	0	2	1
Selected nonscience major									
Education (nonscience)	11	0	4	5	1	4	0	7	5
Business, accounting and other nonscience)	16	0	6	10	3	21	14	23	15
Undeclared major	33	4	10	19	6	21	15	15	14

Fourteen percent of the students taking science classes have not declared majors, 15 percent are following business-oriented programs, including accounting, and another 5 percent are in education. Thus, a total of 34 percent of the students in science classes either do not consider themselves science majors or have not yet decided on their major fields.

The largest number of students who are following what may be broadly described as science-oriented programs are in engineering and mechanical technologies (22 percent). Twelve percent of the science students have declared nursing as their major, and other health-related occupations have been chosen by ten percent of the students. Only seven percent of the students identify themselves as traditional science majors (biological sciences, 3 percent; engineering, 2 percent; physical sciences, 1 percent; mathematics, 0.5 percent; and unspecified science, 0.3 percent).

As shown in Table 3-33, large proportions of students taking courses in introductory biology, mathematics, and social sciences are nonscience majors or have not declared majors. These fields, along with physical sciences, include the introductory courses that are the core subjects for all college degrees. The large percentages of nonscience and undeclared majors in these fields emphasize their "service" function in two-year college education.

The relatively large percentages of business and accounting majors in computer science reflect the importance of that field to those majors. In fact, if other computer courses (in business management departments, for example) had been included in the survey, a much larger number of students would be shown in the computer science field, and a majority of these would be business majors.

It is noteworthy that very small percentages of the students enrolled in biology -- either introductory or advanced -- are majoring in biology or other traditional science fields. The same is true for physical sciences and mathematics. The primary function of courses in these fields is to serve general education students, technology students, and health sciences and nursing students.

b. Purpose in Attending College

Students were asked

> *What was your most important educational purpose for attending this college when you first enrolled?*

and

> *What do you now consider your most important educational purpose?*

Not surprisingly, the responses to these questions reflect some changes over time. The length of time is of course variable, depending on the year a student first enrolled. Table 3-34 shows the percentages of students whose purposes have changed or have remained the same.

The diagonal indicated in this table represents the students whose educational purposes have not altered from their original enrollment to the date of the survey. Thus, 64 percent of those who first enrolled with the intent of obtaining associate degrees and then transferring to four-year colleges stated that this is still their intention. However, 12 percent decided by the time of the survey to transfer before obtaining the associate degree, and another 12 percent decided to take the degree, not transfer, and go to work instead.

Table 3-34. Percent distribution of students, by original and present purpose for attending college

Present purpose	Original purpose								Total
	Obtain associate degree and then transfer	Take some college courses and transfer	Obtain associate degree and find employment	Obtain certificate to upgrade skills	Obtain training in special program	Take one or more courses of special interest	Try college to see if I like it	Other	
Obtain associate degree and then transfer to 4-year institution	$\boxed{64}$	25	30	22	17	34	45	33	42
Take some college courses and transfer without obtaining associate degree	12	$\boxed{62}$	4	1	5	3	16	5	15
Obtain associate degree and find employment	12	5	$\boxed{54}$	8	19	23	30	12	22
Obtain certificate to upgrade skills	4	2	3	$\boxed{50}$	4	5	0	3	5
Obtain training in special program	3	1	6	16	$\boxed{52}$	9	1	0	9
Take one or more courses of special interest	2	2	2	2	0	$\boxed{27}$	2	1	3
Try college to see if I like it	1	1	0	0	0	0	$\boxed{1}$	10	1
Other	2	3	3	2	2	1	1	$\boxed{35}$	3
Row total percent	40	13	23	6	9	5	4	1	100

$\boxed{\ }$ = Percent of students who have not changed purpose from enrollment to survey time.

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Students whose initial purpose was to earn degrees and then go to work also reported changes. Only 54 percent still intend to follow their original plan. Another 30 percent intend to transfer to four-year colleges after receiving their degrees. In fact, that option -- transfer after receiving the associate degree -- is the most frequently elected change. The minor exception is those students who decided to pursue training in special programs. Of the students trying college to see if they like it, over 60 percent decided to transfer, most of them after obtaining the associate degree. Overall, 42 percent of the students plan to obtain associate degrees and transfer.

Table 3-35 and 3-36 show students' current intentions by educational field and college type. Transfer after obtaining a degree is the most popular choice in all fields, except for engineering and technology students who wish to find employment after completion of their degrees. The extent to which students desire to transfer to four-year colleges, whether before or after receiving associate degrees, should be noted. This intention is stated by over 70 percent of those students in introductory biology, physical science, and mathematics.

Table 3-36 shows that students in technical institutes are more concerned with immediate employment (43 percent) than students in any other type of school, and yet surprisingly only 11 percent seek training in special programs.

c. Highest Degree Sought

One important indicator of educational goals is the highest degree students intend to seek. The study found that only 12 percent of the students plan to stop with the associate degree, while 13 percent have not decided how far they will go.

Table 3-35. Percent distribution of students' purposes in attending college, by educational field

Purpose	Educational field							
	Intro-ductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathe-matics	Computer sciences	Social sciences
Obtain associate degree and then transfer to 4-year institution	55	33	34	47	33	48	34	46
Take some college courses and transfer without obtaining associate degree	22	16	13	25	9	27	17	16
Obtain associate degree and find employment	5	30	30	14	34	13	21	19
Obtain certificate to upgrade skills	6	4	4	3	10	3	11	4
Obtain training in special program	8	13	14	6	9	2	12	8
Take one or more courses of special interest	3	1	2	2	2	4	5	3
Try college to see if I like it	0	1	1	1	0	1	0	1
Other	1	2	4	3	3	2	0	3

le 3-36. Percent distribution of students' purposes in attending college, by type of college

Purpose	Type of college				
	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive
ain associate degree nd then transfer to -year institution	29	56	50	41	43
e some college courses nd transfer without btaining associate egree	5	15	17	15	18
ain associate degree nd find employment	3	14	12	25	17
ain certificate to pgrade skills	7	2	8	4	6
ain training in pecial program	11	6	10	8	9
e one or more courses f special interest	2	1	2	3	4
college to see if I ike it	1	1	0	1	1
er	3	5	2	2	3

Only one percent state that they do not intend to earn any degree. The reminder -- 75 percent -- state that they intend to obtain at least bachelor degrees. Moreover, that group is divided into 13 percent who desire doctorates in either clinical or research and teaching fields and 29 percent wanting masters degrees.

Table 3-37. Percent distribution of students' intended highest degree, all students combined

Degree	Total
Associate	12
Bachelor	32
Masters	29
Doctorate	
Research and teaching	8
Clinical practice	5
None	1
Uncertain	13

By educational field (see Table 3-38), the largest group of doctorate seekers is found taking physical science courses. Of those students enrolled in engineering and technology, 37 percent intend to obtain bachelor degrees, and another 30 percent would like to pursue graduate studies. Similar statistics hold true for other programs that usually are considered occupational -- the health fields (including nursing), and computer sciences.

By type of college (see Table 3-39), 21 percent of the students in technical institutes plan to stop at the associate degree level, 38 percent want bachelor degrees, and 22 percent desire graduate degrees. The private colleges have the largest

Table 3-38. Percent distribution of students' intended highest degree, by educational field

Degree	Educational field							
	Introductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathematics	Computer sciences	Social sciences
Associate	5	14	10	8	15	6	9	13
Bachelor	30	35	38	28	37	30	36	30
Masters	38	25	23	30	24	35	30	31
Doctorate								
Research and teaching	7	7	7	13	5	8	8	9
Clinical practice	7	3	10	10	1	6	1	5
None	2	1	1	1	2	1	0	1
Uncertain	12	17	11	12	16	4	15	13

le 3-39. Percent distribution of students' intended highest degree, by type of college

Degree	Type of college					Total
	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Small comprehensive	
ociate	21	3	11	14	11	12
helor	38	29	35	31	30	32
ters	16	45	35	27	30	29
torate						
esearch and teaching	3	8	4	9	10	8
linical practice	3	2	3	5	6	5
e	3	1	1	1	1	1
ertain	15	12	12	14	12	13

proportion of students oriented toward graduate studies, with 45 percent aspiring to masters degrees. The largest proportions desiring doctorates are found in the two larger types of comprehensive colleges.

d. Why Students Enroll in Courses

Students' reasons for enrolling in their courses are presented by field in Table 3-40. The most frequently cited reason is "required for my major." However, there may have been confusion among some students as to the distinction between this choice and "required as part of my general program of studies." The second choice was intended to reflect distribution requirements for introductory courses in several broad academic areas, such as the liberal arts or general education. Even career programs have distribution requirements in such fields as English and social science. It is believe that the number of responses recorded for this second option may represent an underestimate of its true magnitude.

As Table 3-40 indicates, over 75 percent of students in the health and technology fields report that the courses covered in this study are required for their majors. This table also shows that 14 percent of all students are taking these courses because of personal interest, and not as parts of formal programs. Personal interest is most frequently a factor in computer science (20 percent) and social science (18 percent). Not surprisingly, these two

able 3-40. Percent d' :bution of students' reasons for enrolling in courses, b
education ... ld and type of college

Field and Type of college	Reason: Required for major	Required as part of general program of studies	Elective for major or general program	Not part of formal program; taking for personal interest	Othe
ducational field					
Introductory biology	41	40	11	8	0
Health sciences	78	7	4	8	3
Other life sciences	65	15	6	13	1
Physical sciences	61	18	10	10	1
Engineering and technology	72	5	10	9	4
Mathematics	57	18	11	12	2
Computer sciences	56	8	14	20	2
Social sciences	51	15	16	18	0
ype of college					
Technical institutes	76	6	7	10	2
Private colleges	65	17	5	12	1
Small comprehensive	44	16	24	17	0
Medium comprehensive	58	14	13	13	1
Large comprehensive	54	17	11	16	3
Total	57	15	12	14	1

the surveyed courses because they are required for their majors. Small comprehensive colleges, on the other hand, only enroll 44 percent of their students in these courses because they fill major field requirements. This percentage is considerably lower than those for other comprehensive colleges. About one-fourth of the students in small comprehensive schools, far more than in other types of colleges, state that they are taking these courses as electives.

e. Why Students Do Not Declare Majors

Some additional light is shed on students' reasons for enrolling in courses by examining their reasons for not choosing major fields of study. Only 14 percent of all students have not declared majors. Their distribution by educational field and college type is given in Table 3-41. The most frequently chosen reason is that they have not yet decided. This choice was made by large majorities in introductory biology, physical sciences, mathematics, and other life sciences. On the other hand, for those in the health fields, "not following a prescribed course of study" was the most common answer.

These undeclared majors are a small part of the total student population in this study. Yet they constitute more significant proportions of students in certain educational fields. Table 3-41 also shows that 29 percent of all students enrolled in introductory biology and 18 percent of those in mathematics have not declared majors.

The great majority of private college students who are undeclared majors said that they have not yet decided on fields of study (86 percent). Students in small comprehensive colleges generally indicated that they are not following prescribed courses

Table 3-41. Percent distribution of students' reasons for not declaring majors, by educational field and type of college

Field and type of college	Reason			
	Not yet decided on a major	Not following a prescribed course of study	Other	Percent of all students
Educational field				
Introductory biology	74	17	10	29
Health sciences	0	63	37	3
Other life sciences	58	28	14	8
Physical sciences	64	22	14	16
Engineering and technology	38	48	14	6
Mathematics	60	19	21	18
Computer sciences	42	41	18	12
Social sciences	43	41	16	13
Type of college				
Technical institutes	41	26	34	6
Private colleges	86	10	4	8
Small comprehensive	41	51	8	16
Medium comprehensive	56	30	15	15
Large comprehensive	41	41	18	18
Total	48	37	15	15

of study and, hence, have not declared majors. The three comprehensive college types enroll about the same proportions of students without majors -- 15 to 18 percent.

3.4.7 Students' Employment Status

Sixty-five percent of the students taking science courses are employed full-tir or part-time. The percentage is higher for men than for women (72 percent versus 60 percent). Students in the health sciences have the lowest employment rate (54 percent). By college types, the lowest student employment rate is found in private colleges (50 percent). In the large comprehensive schools, 70 percent of the students are employed (see Table 3-42).

3.4.8 Reasons for Choosing Colleges

Why do students select a particular college, aside from their general desire for an education and for particular courses of study? Their reasons are summarized in Table 3-43 and 3-44 by college type, sex, age, and race or ethnic group. Because they could indicate more than one reason for their choice, the percentages for each choice total more than 100 percent.

Students most frequently cited convenient location as their reason for choosing a particular college (73 percent). Fifty percent indicated cost as an important factor; reputation of college received a response of 33 percent, and courses meeting at convenient times, 25 percent.

When reasons for college choice are analyzed by type of college (see Table 3-43), it is found that, while convenience of location is important for all college types, it was mentioned

Table 3-42. Percent distribution of students employed, by educational field, type of college, and sex

	Employed	Not employed
Educational field		
Introductory biology	57	43
Health sciences	54	46
Other life sciences	63	37
Physical sciences	63	37
Engineering and technology	65	35
Mathematics	64	36
Computer sciences	62	38
Social sciences	64	36
Type of college		
Technical institutes	58	42
Private colleges	50	50
Small comprehensive	67	33
Medium comprehensive	65	35
Large comprehensive	70	30
Sex		
Men	72	28
Women	60	40
Total	65	35

Table 4-43. Percent distribution of students' reasons for choosing colleges, by type of college and racial/ethnic group

Reason	Type of college					Racial or ethnic group				
	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive	American Indian or Alaskan Native	Asian or Pacific Islander	Black	White	Hispanic
Lower cost than other colleges	42	4	46	54	58	86	49	24	52	48
Convenient location	54	50	90	75	75	74	66	58	74	82
Courses meet at convenient time	17	14	24	23	31	52	25	21	24	37
Reputation of college	51	51	17	31	32	28	18	40	33	28
Other	14	25	3	6	7	4	3	7	9	8

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Table 3-44. Percent distribution of students' reasons for choosing colleges, by sex and age

Reason	Sex		Age							
	Male	Female	<18	18-19	20-21	22-25	26-29	30-44	45-59	≥60
Lower cost than other colleges	50	51	45	49	66	50	43	44	35	62
Convenient location	72	74	87	70	70	69	76	80	86	80
Courses meet at convenient time	26	24	36	17	26	22	30	33	36	53
Reputation of college	32	34	42	35	37	32	28	31	23	36
Other	7	9	5	9	9	10	7	6	8	2

by 90 percent of the students in small comprehensive schools and 75 percent in each of the two larger comprehensive types. Convenience of course meeting times is most important for students in the large comprehensive colleges (31 percent). Reputation of college is a significant factor for students in technical institutes and private colleges (both 51 percent). As would be expected, the cost factor is negligible for private colleges, which charge tuition far above the public college rates. The four percent who claimed costs were lower at private colleges might have done so for personal reasons.

There are no significant sex differences in reasons for selecting colleges. Age differences do exist, however. For the 20-21 year age group, and for students over 60, lower costs are more important. Convenient location is important for all groups, but particularly so for those under 18 and still in high school (87 percent) and for all adults 30 and over. Convenience of course meeting times is quite important for students over 60, and at least moderately so for those under 18 and over 30. College reputation received responses from 42 percent of the students under 18 and 23 percent of the 45-59 year age group.

American Indians and Alaskan Natives ranked all factors high except for college reputation. Convenient location and convenient course meeting times were of major concern to Hispanics, while blacks emphasized college reputation more than did other groups.

4. SCIENCE EDUCATION NEEDS IN TWO-YEAR COLLEGES: ADMINISTRATORS' PERSPECTIVE

4.1 Overview

A major objective of this study is to identify areas of science education needing improvement in two-year colleges. Data have been obtained from administrators, faculty members, and students enrolled in science courses. This chapter presents an analysis of data from administrators; the next two chapters will deal with information obtained from faculty and students.

College administrators provided a general view of various aspects of science education programs across all educational fields. Included were judgments on which fields are critically in need of improvement, the types of improvement required, faculty needs, students needs, use of part-time faculty, and problems of articulation with four-year colleges.

The presentation of data in this and the next two chapters is organized according to the questionnaire items relevant to each section of the chapter. The questionnaire items can be identified easily from the questionnaires included in Volume 2, Appendix E.

These chapters focus only on data that are considered significant. Some of the more detailed data have been included in Volume 2, but are not discussed in-depth in the text of this volume. Readers may refer to Appendix D of Volume 2 for details not contained in these chapters.

4.2 Educational Fields That Need Improvement

<u>Question:</u> *Indicate which [educational fields in science and technology] critically need improvement. For each field that needs improvement circle . . . all types of improvement needed. Then rank order the three educational fields that have top priority beginning with 1 as the highest.*

4.2.1 Educational Fields

About four percent of the administrators stated that their schools have no fields in critical need of improvement. However, more than 50 specific fields were mentioned by one or more of the other respondents. The total numbers of fields mentioned (by 11 broad curriculum areas) are presented in Table 4-1. As this table indicates, an average of 5.6 fields for all colleges are considered as needing improvement.

While Table 4-1 displays a general needs assessment of educational fields, as perceived by administrators, it does not show the relative degree of need among specific fields. For example, it is not clear from this table whether computer sciences require more improvement than physical sciences. Therefore, the ten most frequently mentioned fields are presented in Table 4-2. In this table it is shown that, for all colleges, the field most often designated is computer sciences, followed by chemistry, mathematics, physics, and biological sciences. The frequency with which each field was mentioned is closely parallel to the priorities assigned by administrators. For example, computer science also ranks the highest in need of improvement.

Ranking of fields in need of improvment varies among the five types of colleges. Technical institutes rank electronic

Table 4-1. Broad curriculum areas that need improvement as indicated by the number of times they were mentioned by administrators

Broad curriculum area	Total number of times mentioned*	Number of times mentioned per college
Agriculture and natural resources	181	.1
Biological sciences	1,125	.9
Computer and information sciences	559	.5
Engineering	170	.1
General science and interdisciplinary sciences	184	.1
Mathematics	478	.4
Nursing	3.7	.3
Physical sciences	1,430	1.2
Social sciences	800	.6
Mechanical engineering and natural science technologies	1,160	.9
Health related occupations	508	.4
Total	6,912	5.6

*This column indicates the number of cases from which the percentages for each curriculum area were calculated. However, the size of these numbers is an artifact of the number of individual educational fields appearing under each broad area. A respondent had an opportunity to mention 16 different technologies and six separate social science disciplines, but only one opportunity to mention mathematics. As shown in Table 4-2, mathematics is one of the areas most frequently mentioned, but individual educational fields under social science and technologies appear less frequently. Such individual disciplines as chemistry and physics are among the most frequently mentioned. Therefore, the numbers in this column should not be used to compare broad curriculum areas.

Table 4-2. Percent distribution of ten educational fields most frequently mentioned as critically needing improvement: all colleges combined (N=1,232)

Field	Percent of administrators mentioning field	Percent giving priorities 1, 2, or 3
Computer and information sciences	45	30
Chemistry	41	23
Mathematics	39	16
Physics	37	18
Biological sciences (undifferentiated)	33	16
Nursing	26	12
Electronics technologies	22	8
Psychology	16	2
General science and interdisciplinary studies	15	6
Microbiology	14	7

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technologies as most in need of improvement and also are concerned about agriculture and agricultural technologies. The ratings for these latter two fields are a result of the inclusion of agriculturally oriented colleges among the technical institutions. Private colleges are most concerned with chemistry and physics, and they show at least a moderate concern for a number of subfields in biology, such as physiology, zoology, and microbiology. Psychology appears in the first ten only on the lists of private colleges and small comprehensive schools, but because it is mentioned infrequently by all other types, it ranks as the eighth most frequently mentioned field. It is the only social science to elicit this degree of concern. Nursing also appears on the lists of three types of colleges and ranks sixth for all colleges in number of times mentioned. More detailed data on educational fields mentioned, by each type of college, as well as priority rankings for those fields, are provided in Appendix D.

4.2.2 Types of Improvement Required for Fields in Critical Need

Respondents were asked, in the first question of the institutional questionnaire, to indicate the types of improvements needed for each field mentioned, using these five improvement categories:

- Facilities
- Equipment
- Restructuring of course content
- Instructional methodologies
- Faculty development

Analysis of responses to this question requires a consolidation of educational fields to discern the patterns in the responses because the respondents could choose from a total of fifty detailed educational fields, and many fields were listed only by one or two respondents. Most of these detailed educational fields are related and fall into broad curriculum areas, as do responses in the improvement categories. For example, in the specific disciplines within the broad areas of biological sciences or technology the relative demand for equipment improvement versus teacher development is very similar. It is, therefore, possible to cluster the individual educational fields into broad curriculum areas to illustrate the patterns of needs in the various areas of two-year college curriculum.

Table 4-3 presents data on the relative importance of the five improvement categories in eleven broad curriculum areas for all colleges combined. The table entries have been calculated as percentages of the numbers of times a field was mentioned within the broad area. These data show that, for all colleges and across all fields mentioned by any respondent, the most critically needed type of improvement is for equipment (65 percent), followed by facilities improvement (54 percent) and faculty development (51 percent). Course content restructuring or educational methodologies were mentioned only about one-third of the time, although there are fields (e.g., social sciences, general science, and interdisciplinary studies) for which these categories received higher ranking. The general conclusion is that hardware is the most pressing need, with both facilities and faculty improvement also high on the list.

However, the emphasis given types of improvement varies among the broad curriculum areas (see Table 4-3). For example, of all fields mentioned within the broad area of mechanical engineering and natural science technologies, 79 percent of the ble 4-3. Percent distribution of improvements required for educational fields most critically needing improvement, by broad curriculum area and improvement type: all colleges combined

Broad curriculum area	Type of improvement				
	Facilities	Equipment	Restructuring of course content	Instructional methodologies	Faculty development
riculture and natural resources	78	65	34	20	53
ological sciences	46	6[illegible]	27	24	46
mputer and information sciences	67	87	34	31	62
gineering	41	60	24	19	33
neral science and interdisciplinary sciences	42	49	48	40	61
thematics	37	38	38	4[illegible]	45
rsing	72	76	19	27	48
ysical sciences	53	71	24	30	43
cial sciences	30	28	38	50	56
chanical engineering and natural science technologies	71	79	44	37	63
alth related occupations	69	67	26	32	50
Total	54	65	32	33	51

time the same respondents indicated a need for equipment; 71 percent of the time, a need for facilities improvement; and 63 percent of the time, a need for faculty development. This pattern (high need for equipment, nearly as high for facilities, and slightly lower for faculty development) is repeated for other career fields, including nursing, health-related occupations, and computer sciences.

In contrast to the pattern of needs of career fields is the pattern of the nonlaboratory, basic fields of mathematics and social sciences. These fields show a relatively low need for facilities and equipment, with moderate need for faculty development. The laboratory sciences related to career fields and other advanced science curricula (biological and physical sciences and engineering) are rated high principally on the need for equipment.

The computer sciences show a pattern highly similar to the technology area; the physical sciences and biological sciences are somewhat different from these two, although similar to each other. Mathematics shows a relatively low and even overall pattern, with a low peak for faculty development (45 percent).

The types of improvements needed vary among the different types of colleges. As shown in Table , private colleges mentioned needs in specific educational fields 897 times. Forty-eight percent registered facilities needs, and only 2 percent listed need for improvement in instructional methodologies; 50 percent specified teacher development as a critical need. Technical institutes, on the other hand, differ in their needs for improvement. Their greatest needs are for facilities and for equipment (69 percent each), followed by teacher development (66 percent) and instructional methodologies and resturcturing of course content (33 percent each). Large comprehensive colleges are particularly high in their perceived need for equipment (72 percent).

Table 4-4. Percent distribution of types of improvement required, by type of college: all broad curriculum areas combined

Type of college	Type of improvement				
	Facilities	Equipment	Restructuring of course content	Instructional methodologies	Teacher development
Technical institutes	69	69	33	33	66
Private colleges	48	60	30	2	50
Small comprehensive	47	64	28	21	47
Medium comprehensive	53	63	34	39	49
Large comprehensive	55	72	34	37	45
Total: all colleges combined	54	65	32	33	51

4.3 Facilities and Equipment

The first question of the institutional questionnaire ascertained the educational fields that administrators believe are most critically in need of improvement, as well as the general types of improvement each of these requires. If they mentioned facilities or equipment in this question they were asked to elaborate on these needs in the next question. In addition, three more questions dealt with other aspects of needs for facilities and equipment. These four questions are treated below in sequence.

4.3.1 Kinds of Facilities and Equipment Improvements Needed

<u>*Question:*</u> *For those educational fields listed in Question 1 that need <u>equipment and/or facilities improvement, indicate</u> . . . the kinds of improvements needed.*

Needs for facilities and equipment can be subdivided into requirements for lecture-demonstration equipment and for laboratories. Laboratories themselves serve different functions. There are: 1) general purpose laboratories for use in several courses within a discipline, or even in more than one discipline; 2) specialized laboratories, such as those used in microbiology or in a number of the technologies; and 3) laboratories specially designed for self-instructional courses, usually employing audio-visual materials. Each of these kinds of laboratories may need facilities and/or equipment. Provision was made for separate designation of each of these sub-categories.

The data for the 11 broad curriculum areas for all colleges combined are presented in Table 4-5. Overall, the need

Table 4-5. Percent distribution of facilities and equipment improvements needed, by type of facility or equipment, type of improvement, and broad curriculum area: all colleges combined

Broad curriculum area	Lecture-demonstration: Construction or renovation	Lecture-demonstration: Specialized hardware for science and technology	Laboratories: General purpose: Construction or renovation	Laboratories: General purpose: Major equipment	Laboratories: Specialized: Construction or renovation	Laboratories: Specialized: Major equipment	Laboratories: Self-instructional, media-assisted: Construction or renovation	Laboratories: Self-instructional, media-assisted: Major equipment
Agriculture and natural resources	69	28	60	40	47	59	7	25
Biological sciences	27	36	43	53	25	45	12	36
Computer and information sciences	29	52	38	63	25	55	21	42
Engineering	16	46	38	53	9	47	9	27
General sciences and interdisciplinary sciences	50	53	44	62	33	46	32	49
Mathematics	53	29	23	20	4	10	42	46
Nursing	32	43	36	37	41	67	31	49
Physical sciences	28	41	37	54	24	44	21	25
Social sciences	38	[illegible]	36	18	17	28	24	37
Mechanical, engineering and natural science technology	42	49	46	47	59	74	27	44
Health related occupations	42	47	38	34	64	66	29	36
All colleges*	36	41	40	47	34	52	23	37

*The percentages in this row were calculated as the total number of times each improvement type was mentioned ÷ the total number of times broad curriculum areas were mentioned x 100.

for equipment has outpaced the need for construction in all curriculum areas. The proportions of fields in need of equipment range from a low of 37 percent for self-instructional, media-assisted laboratories to a high of 52 percent for specialized laboratories.

Differences among the curriculum areas show wide disparity between facility and equipment needs and in some cases run counter to the overall trend. Agriculture, for example, shows a strong need for construction or renovation of lecture-demonstration facilities and general purpose laboratories, as opposed to equipment needs. Mathematics shows a surprisingly high need for construction or renovation of lecture-demonstration facilities, as do the social sciences for both lecture-demonstration and general purpose facilities.

Table 4-6 looks at the differences among types of colleges in their facilities and equipment needs. The second column in this table shows the relative demand for facilities or equipment improvement for each type of college. From the figures in this column it is clear that the greatest need for facilities and/or equipment improvements is perceived by technical institutes and large comprehensive colleges, a finding that correlates with the results of the first question (see Table 4-4). The smallest level of need was registered by private colleges, but such a response does not negate the fact that there are equipment and facilities needs in those schools as well. Technical institutes most need special purpose laboratories, while private colleges need general purpose laboratories. Here again the large comprehensive colleges parallel the technical institutes in needing special purpose laboratories most of all, although the level of need among large colleges is not as sharply defined. For all types of colleges, however, the need for equipment consistently transcends the need for construction.

Table 4-6. Percent distribution of facilities and equipment improvements needed, by type of facility or equipment, type of improvement and type of college: all broad curriculum areas combined

Type of college	Lecture-demonstration		Laboratories					
			General purpose		Specialized		Self-instructional, media-assisted	
	Construction or renovation	Specialized hardware for science and technology	Construction or renovation	Major equipment	Construction or renovation	Major equipment	Construction or renovation	Major equipment
Technical institutes	52	42	41	38	52	60	37	50
Private colleges	31	48	50	66	31	42	3	18
Small comprehensive	27	43	34	48	24	50	14	28
Medium comprehensive	34	36	44	46	30	50	28	39
Large comprehensive	28	45	33	47	43	55	19	37
All colleges*	36	41	40	47	36	52	23	37

*The percentages in this row were calcuated as the total number of times each improvement type was mentioned ÷ the total number of times broad curriculum areas were mentioned x 100.

4.3.2 Adequacy of Present Facilities

Question: *What percent of the facilities available for science and technology are in need of improvement?*

Respondents were asked to reply to this question by selecting one of four rather broad categories, ranging from less than 25 percent of their facilities needing improvement to over 75 percent needing improvement. Figure 4-1 shows that 53 percent of all colleges consider that improvement is necessary for more than 25 percent of their facilities; this figure varies from 64 percent of the private colleges to 45 percent of the large comprehensive institutions.

Figure 4-1 also shows the median percentage of facilities needing improvement. For all colleges combined the median is 27 percent. The medians for individual types of colleges range from 36 percent for technical institutes and private colleges to 23 percent for medium and large comprehensive institutions.

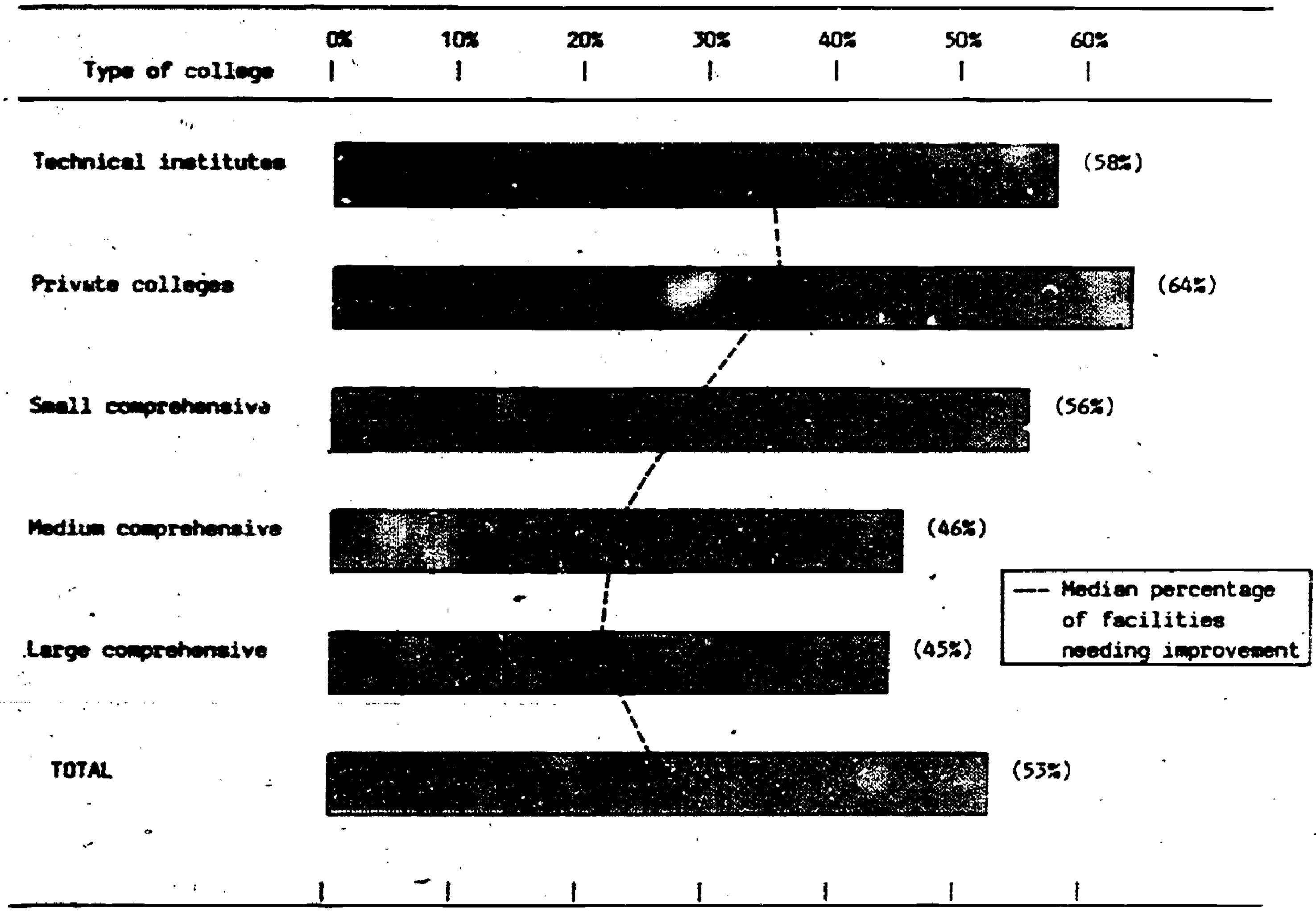
4.3.3 Additional Construction or Hardware

Question: *If this college needs major construction or hardware . . . not already included in Questions 1 through 3, please list them below.*

Still another perspective on facility needs is obtained from the free-answer replies to this question.

Table 4-7 indicates that once again the need for computer equipment or installation is predominant. Forty-three percent of the institutions replied to this question; computer

Figure 4-1. Percent distribution of administrators indicating that more than 25 percent of their colleges' facilities need improvement, by type of college



ble 4-7. Percent distribution of major construction or hardware needs not reported elsewhere, by type of need and type of college

Type of need	Type of college					
	Technical institutes	Private colleges	Small compre-hensive	Medium compre-hensive	Large compre-hensive	Total
mputer equipment or installation	75	75	87	64	72	74
w buildings or class-rooms	25	37	22	38	38	33
boratories	15	33	34	30	35	31
boratory equipment	10	4	20	4	0	7
chinery	0	0	15	11	33	11
ray or cardiology equipment	6	0	0	13	0	4
inics	2	0	0	0	17	2

te: Percentage in each category is based on the number of institutions replying to this question.

equipment or installation was mentioned by almost three-fourths of these respondents as being a primary need, with new buildings or classroom and laboratories being mentioned by approximately one-third.

4.3.4 Library and Instructional Media Materials

<u>*Question:*</u> *How adequate are the instructional media available to this campus in facilitating science instruction?*

The analysis of responses to this question shows that there are marked differences among the types of colleges Overall, however, private colleges are least satisfied with their libraries and media materials, and medium comprehensive institutions are most satisfied.

From Figure 4-2 it can be seen that the three classes of public comprehensive colleges seem to have more adequate book collections, while technical institutes and private colleges are relatively less satisfied with theirs. With regard to discipline-oriented journals, however, technical institutes are more satisfied than the other schools.

In general, institutions are least satisfied with the adequacy of their audiovisual materials. The comprehensive colleges, however, are more satisfied with their facilities for audiovisual instruction than are the other types of institutions.

These patterns probably reflect the better funding available to public institutions. The comprehensive public colleges require adequate library and instructional media materials in many educational fields for the wide variety of students they attract. The technical institutes, while almost entirely publicly

Figure 4-2. Administrators' assessment of the adequacy of their colleges instructional media: mean ratings, by type of media and type of college

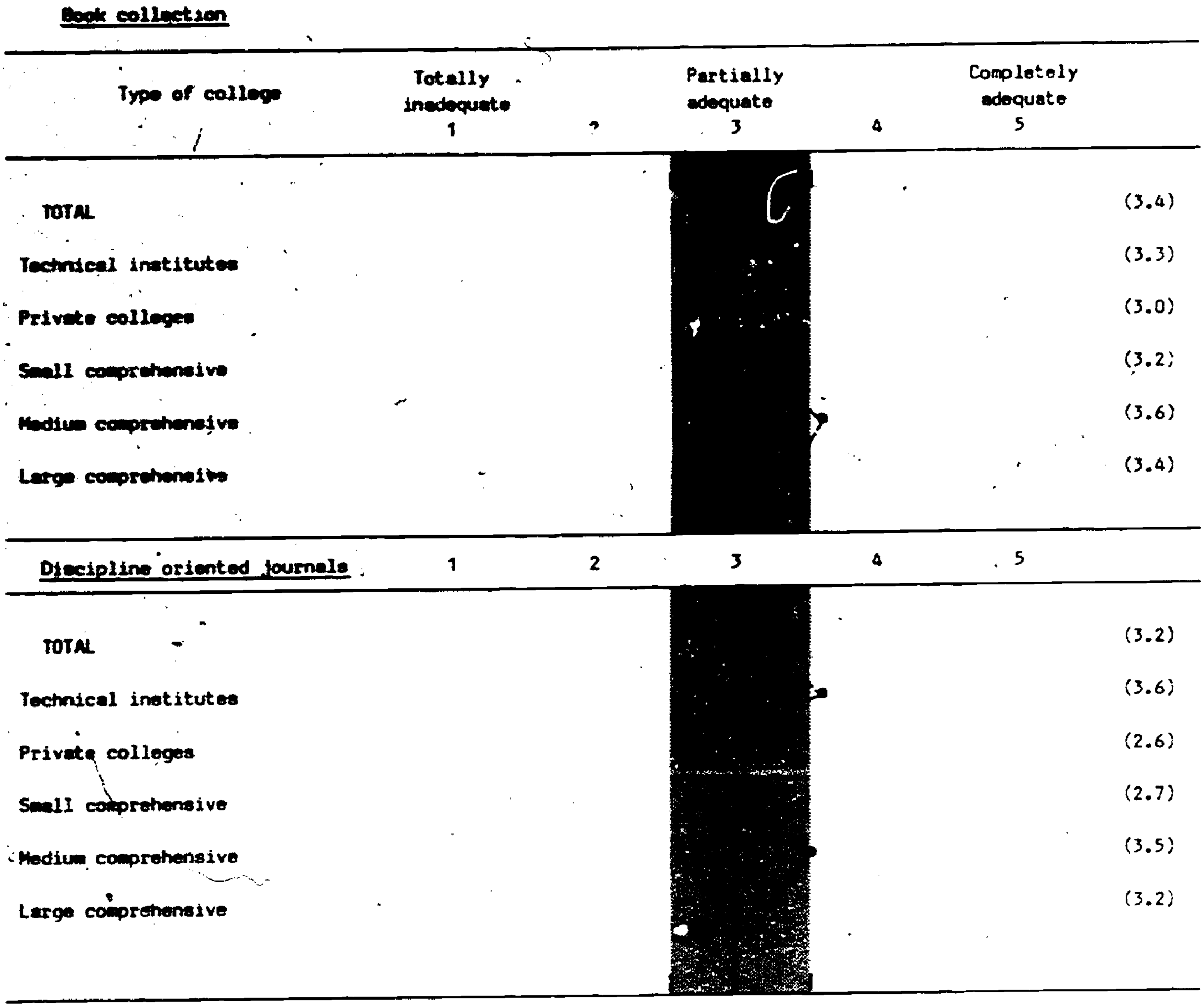


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Figure 4-2. Administrators' assessment of the adequacy of their colleges' instructional media: mean ratings, by type of media and type of college (continued)

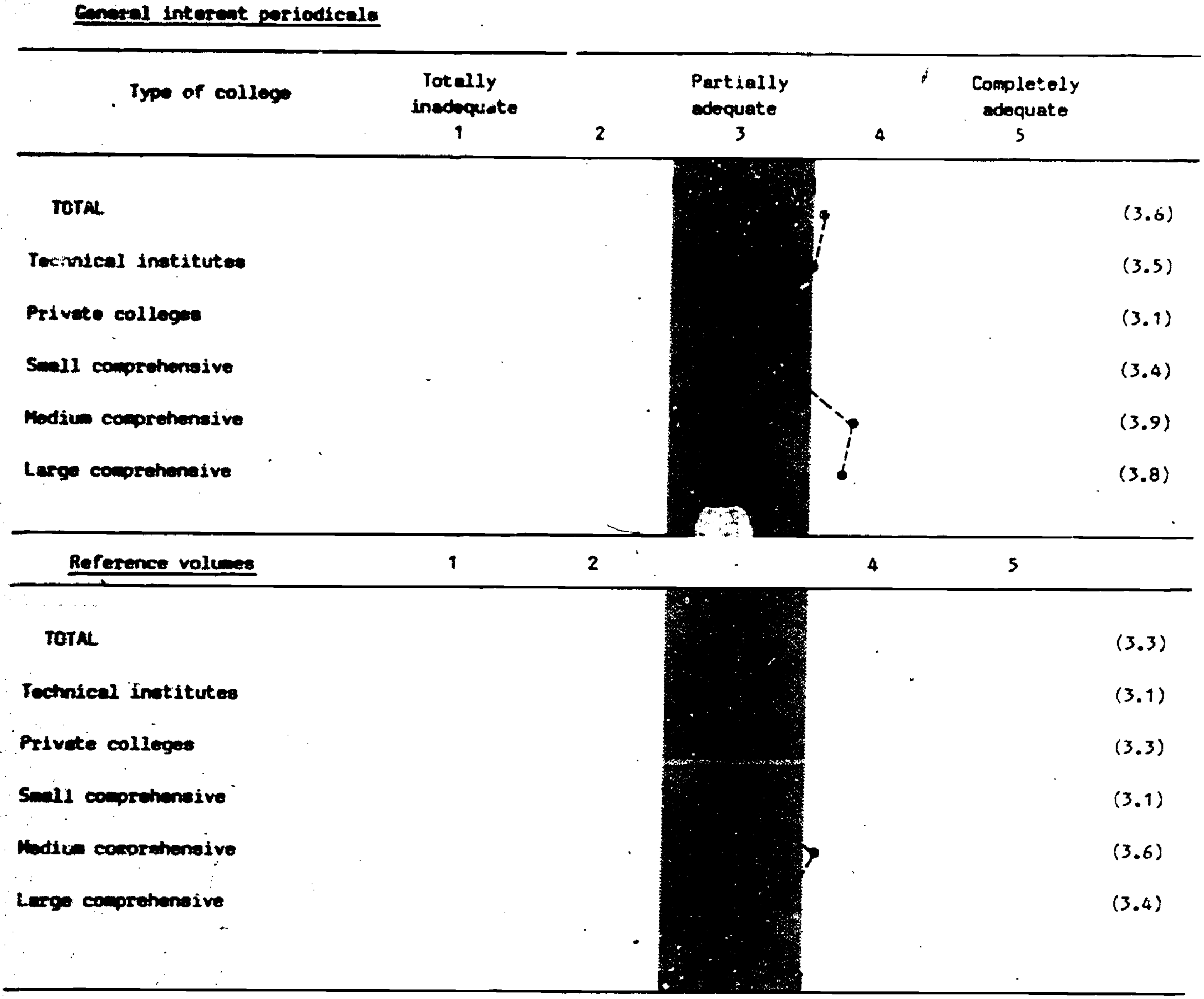

Figure 4-2. Administrators' assessment of the adequacy of their colleges' instructional media: mean ratings, by type of media and type of college (continued)

__Audiovisual media__

Type of college and audiovisual equipment	Totally inadequate 1	2	Partially adequate 3	4	Completely adequate 5	Mean rating
TOTAL						
Facilities						(3.2)
Software						(3.0)
Hardware						(3.1)
Technical institutes						
Facilities						(2.9)
Software						(3.0)
Hardware						(2.9)
Private colleges						
Facilities						(2.9)
Software						(3.2)
Hardware						(2.9)
Small comprehensive						
Facilities						(3.4)
Software						(2.7)
Hardware						(2.8)
Medium comprehensive						
Facilities						(3.4)
Software						(3.2)
Hardware						(3.4)
Large comprehensive						
Facilities						(3.4)
Software						(3.0)
Hardware						(3.2)

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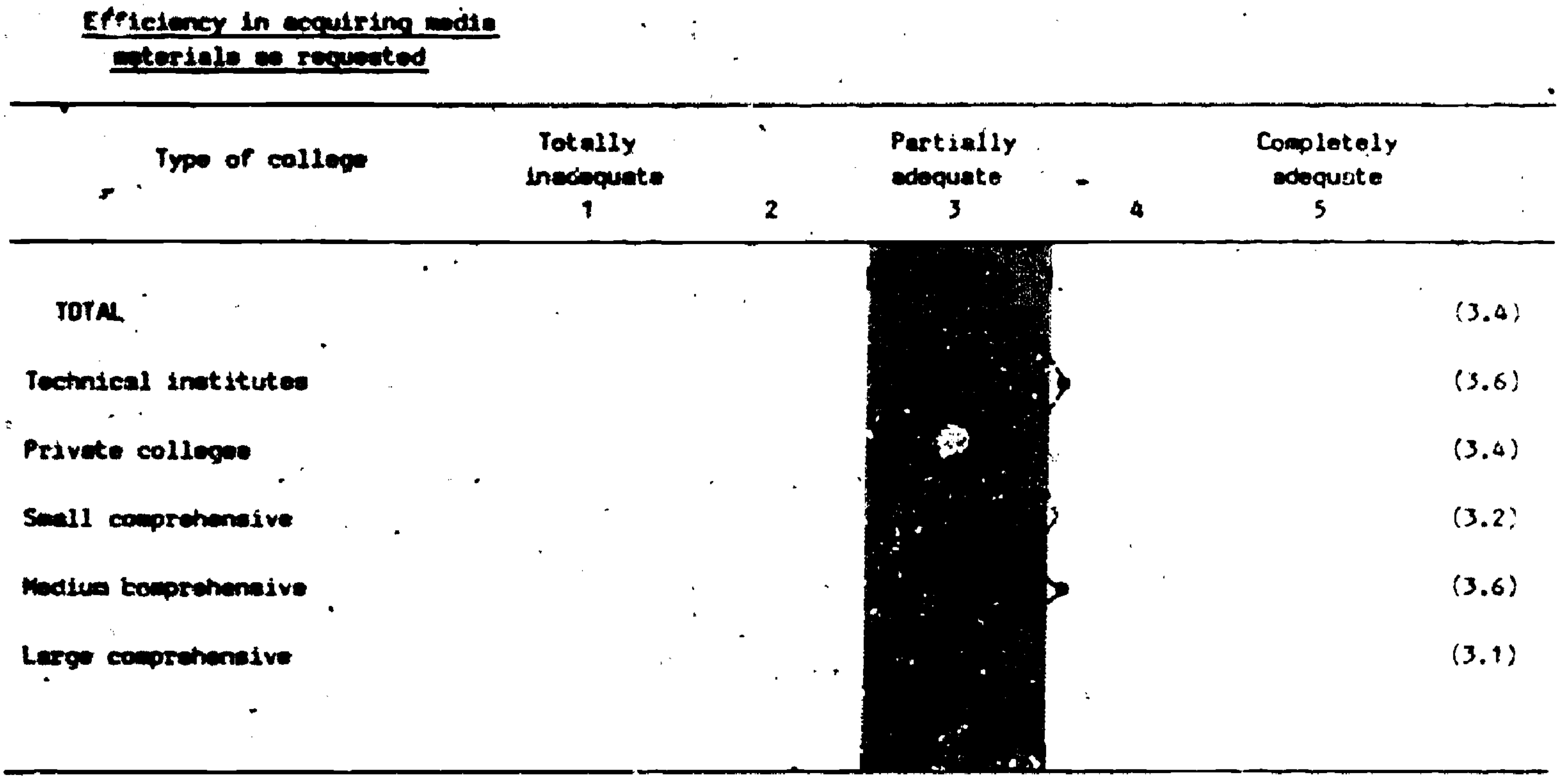
Figure 4-2. Administrators' assessment of the adequacy of their colleges' instructional media: mean ratings, by type of media and type of college (continued)



supported, specialize in technically oriented literature, to the possible exclusion of more general books and journals.

4.4 Faculty Development

Question: *What percent of the science faculty has a critical need for improvement in each of the following aspects of teaching?*

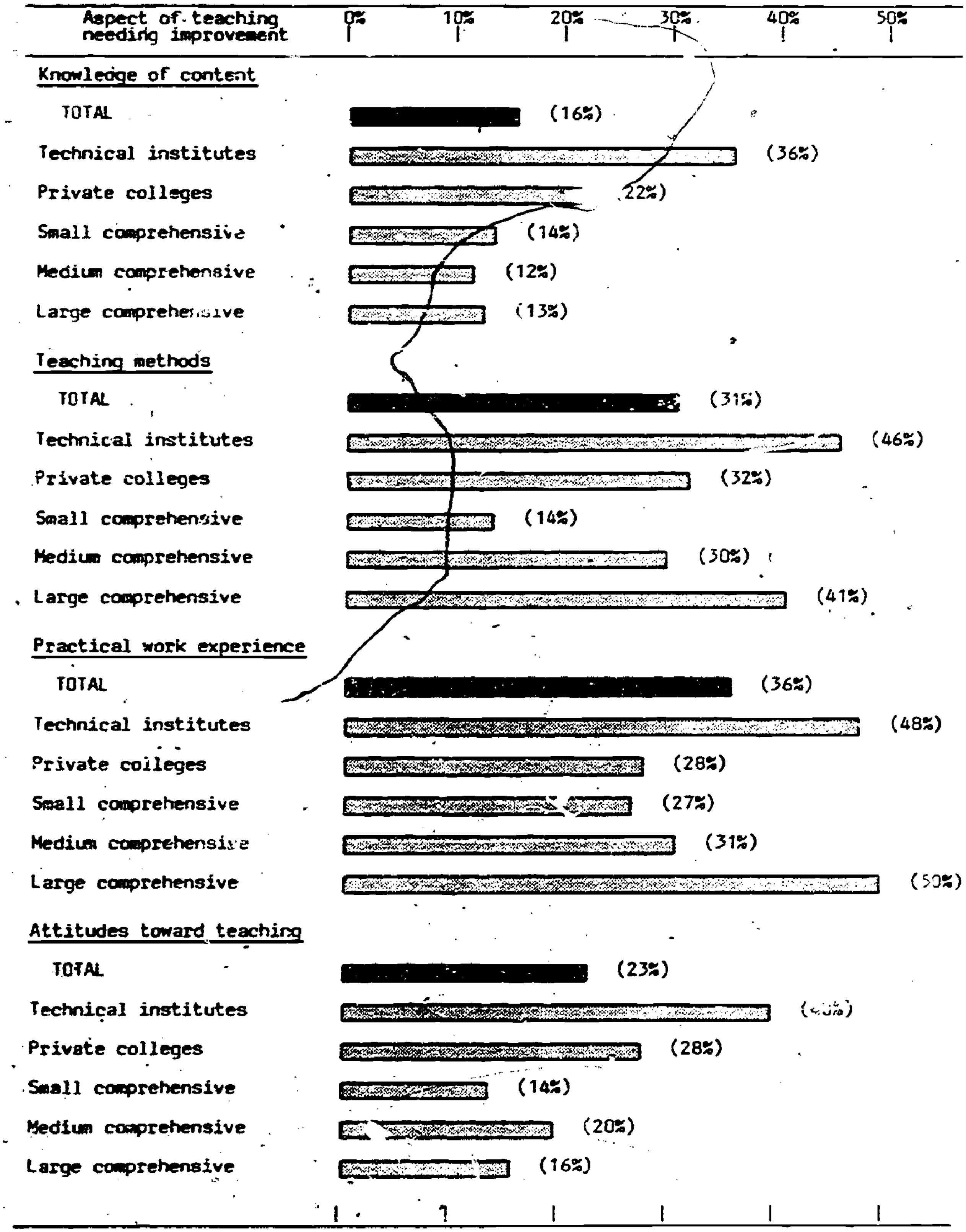
> *Knowledge of content in teaching field*
> *Teaching methods (including instructional media)*
> *Practical work experience related to field of teaching*
> *Attitudes toward teaching*

For each of the four aspects, respondents circled one of five percentage categories, from "less than 20 percent" to "more than 80 percent" of the science teachers on their campuses. The majority of institutions indicated that less than 20 percent of their faculty members need improvement in these aspects. To provide an overall picture of faculty needs, median percents[1] for each type of college are shown in Figure 4-3.

Teaching methods and practical work experience were identified as the aspects of teaching most in need of improvement. Knowledge of subject area content evidently is not of great concern, according to administrators, nor are attitudes toward teaching. Even for the two aspects specified as being most in need of improvement, however, only about 29 percent of all faculty members were identified as being deficient in teaching methods and 26 percent as needing practical work experience. These

[1]A median percent of 20, for example, means that half or more of all institutions indicated that 20 percent or more of their faculty need improvement.

Figure 4-3. Percent distribution of administrators indicating that science faculty members need improvement in teaching: median estimates, by aspect of teaching and type of college



figures do not indicate serious concern on the part of administrators regarding the quality of their faculty.

There are, nevertheless, important differences among the various institutions. As a group, administrators in the small comprehensive colleges estimate their faculty needs as less than any of the others. Technical institutes rate themselves as having the largest percentage of teachers in need of improvement, followed closely by large comprehensive colleges. Both technical and large comprehensive institutions apparently are concerned about lack of practical experience, with 40 percent of their faculty reported in need of such experience.

> <u>Question:</u> *Which of the following options would be most effective in meeting the need for faculty improvement in science instruction for each of the teaching aspects [listed in the preceding question]?*

Following the question on the extent of faculty needs was this question, which sought to identify preferences of administrators for different approaches to strengthen teaching. A number of well established methods for supplementary training of teachers were presented, and respondents were asked to circle those they thought would be most effective. Most of these methods have been used in prior National Science Foundation teacher education programs. They are:

- In-service programs, with the teacher attending part-time during the school year;
- Academic year programs, with the teacher on leave from the school or college and attending a university full-time
- Academic year programs of short but intensive duration, such as NSF's Chautauqua Program, where faculty attend for two or more long weekends and have follow-through assignments;

- Summer programs lasting most of the summer, such as the familiar and very popular Summer Institute, which no longer exists;
- Summer programs of short duration (two to three weeks);
- Self-study materials;
- Attendance at professional meetings; and
- Access to professional literature.

Administrative responses to this question are presented in Figure 4-4, which shows the preferences of the various colleges for helping teachers to improve their classroom performance. Responses to this question do not reflect directly the respondents' estimates of teachers' needs, but rather indicate their judgments as to how effective each approach would be in their particular situations. The figure shows the percent of college administrators who indicated any approach at all as likely to be effective. All eight of the approaches find support in at least some areas by one or more types of colleges. The most positive responses come from the technical institutes and large comprehensive colleges. These two types of institutions rate practically every option as being effective in meeting their needs for faculty improvement. Conversely, private colleges do not rank these options as being particularly effective for their needs.

When administrators were asked to comment on the most effective ways to improve faculty members' knowledge of content, summer institutes and academic year institutes were highly recommended. Even greater approval was given to attending professional meetings and having access to professional literature to improve knowledge of content.

Part-time in-service sessions during the year received very high approval as a means of improving teaching methods.

gure 4-4. Percent distribution of administrators' preferences for faculty improvement, by improvement option and aspect of teaching

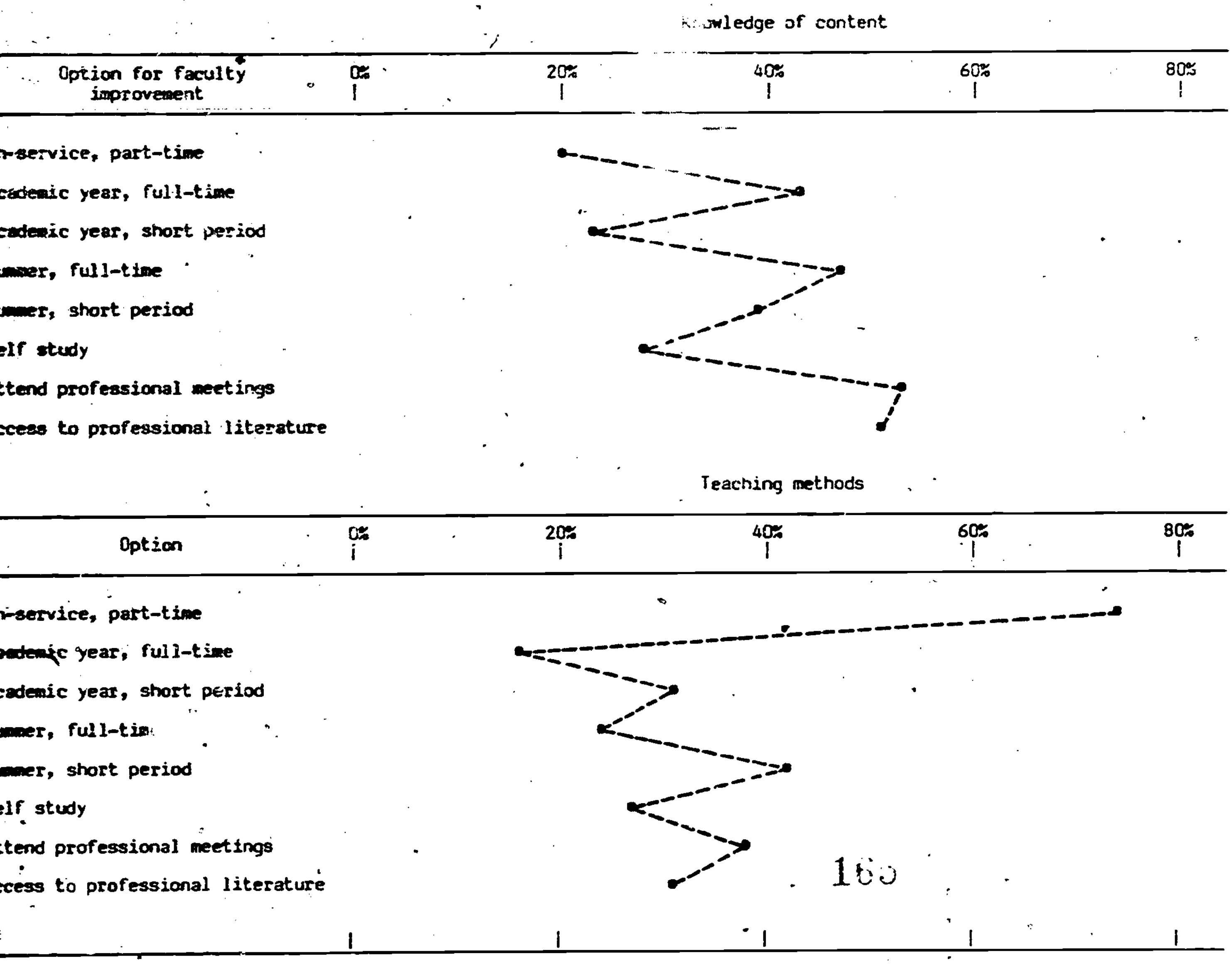
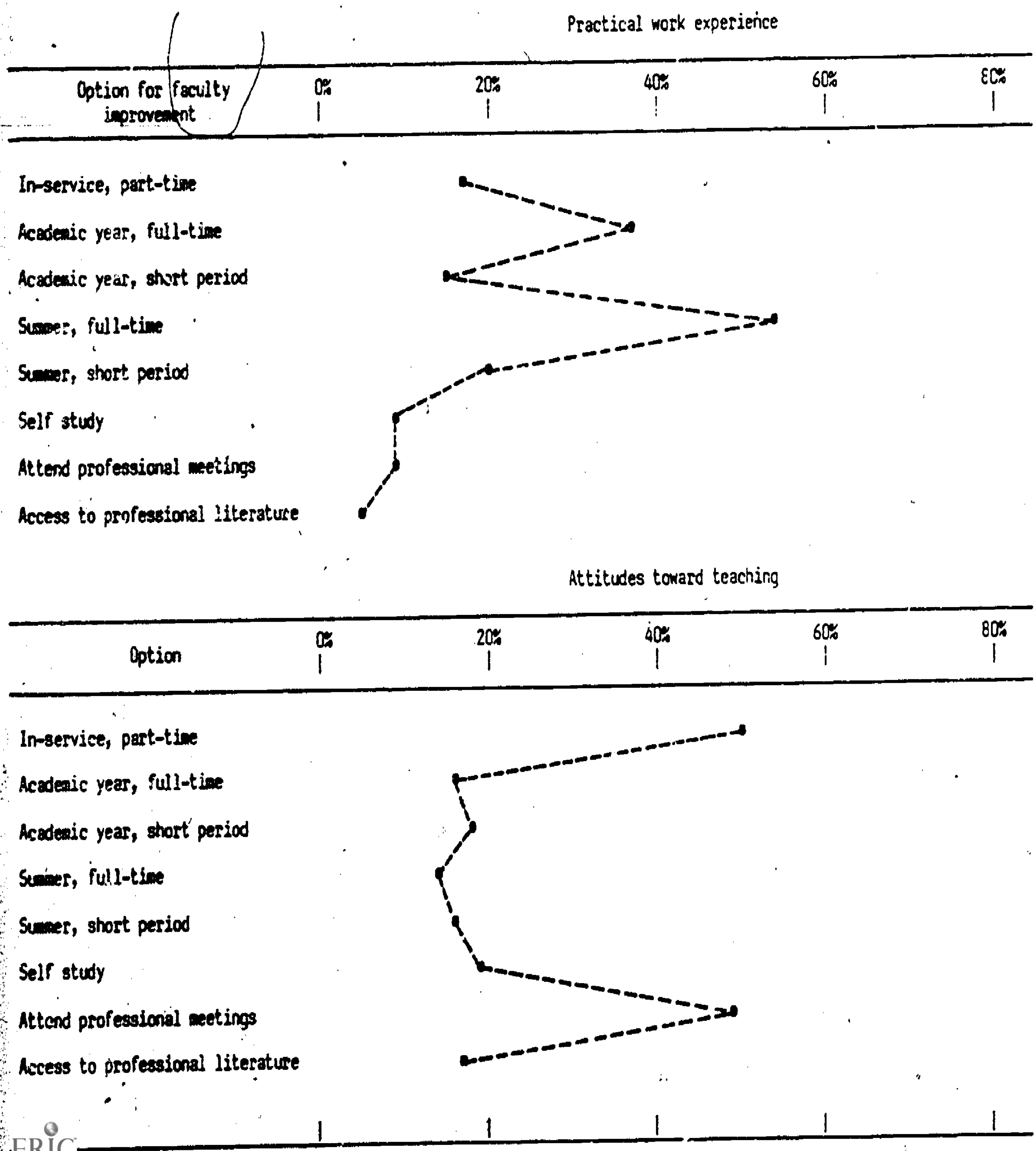


Figure 4-4. Percent distribution of administrators' preferences for faculty improvement, by improvement option and aspect of teaching (continued)



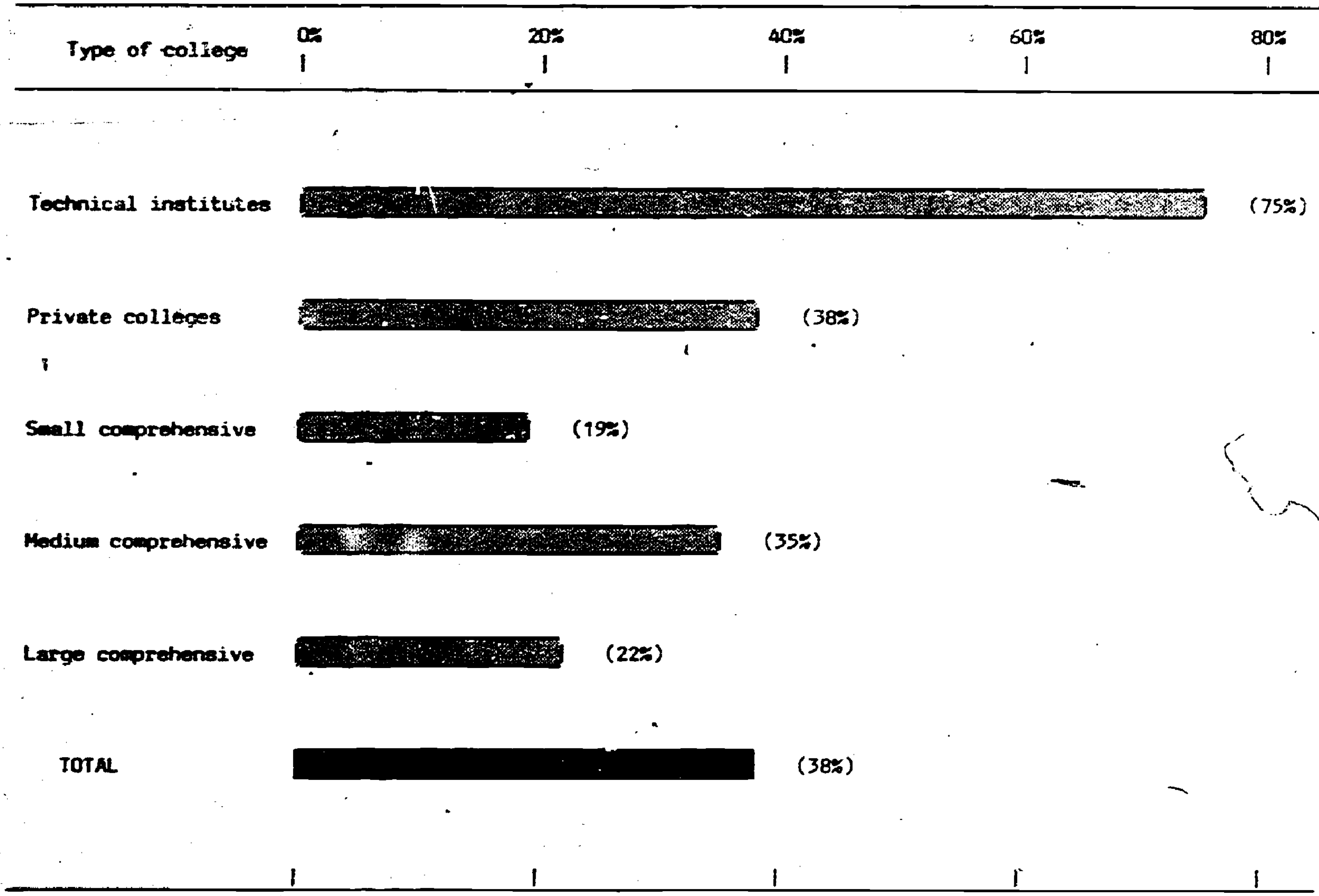
In-service programs are the most preferred method (74 percent) for every aspect of teaching rated in this question. In-service programs also are seen as most useful in improving attitudes toward teaching, especially by technical institutes and large comprehensive colleges. Small comprehensive institutions, however, do not share in this opinion. Administrators in technical institutes and large comprehensive colleges believe that the best way to improve practical work experience for their faculty members is through full-time summer programs and part-time academic year programs.

Of all the options suggested in response to this question, self-study seems the least useful to these respondents. Short, intensive study programs during the academic year, such as the National Science Foundation's Chautauqua Program, do not evoke much enthusiasm among these administrators, even for increasing knowledge of content -- the purpose for which the Chautauqua Program was formulated.

> <u>Question:</u> *During the last five years, what percent of the science faculty has taken advantage of opportunities for self-improvement such as those listed in Question 7?*

This question indirectly provides an estimate of administrators' perceptions of the percent of faculty in need of improvement. Figure 4-5 shows that 75 percent of the technical institutes estimate that more than 60 percent of their science faculty members participated in some sort of self-improvement activity in the last five years. This response is somewhat contrary to the response to the earlier question in which technical institute administrators indicated a greater need for faculty self-improvement than did the other types of colleges. Small comprehensive colleges estimate the lowest proportion of faculty recently involved in self-improvement, and they earlier indicated the least

Figure 4-5. Percent distribution of administrators estimating that more than 60 percent of their colleges' faculty members engaged in self-improvement activities in the last five years, by type of college



need for such activities. The responses of large comprehensive institutions are more consistent with their earlier responses, which showed a relatively great need for faculty self-improvement; in only 22 percent of these colleges had 60 percent or more of the faculty recently participated in any self-improvement activities.

4.5 Use of Part-Time Faculty

Question: *Please check the single most important reason for using part-time faculty for teaching in the science fields at this college.*

Question: *What percent of the faculty members (i.e., head count) teaching in scientific fields at this college campus are part-time?*

Question: *What percent of the course sections in scientific fields is taught by part-time instructors?*

The number of part-time faculty hired to supplement the full-time staff can be an index of the supply of qualified full-time teachers available. There are other reasons for using part-time faculty, however. These are listed in Table 4-8.

The most frequently cited reason for employing part-time faculty is an excess of course sections not great enough to justify hiring additional full-time faculty members (54 percent), followed by the necessity for saving on instructional costs (22 percent). However, small comprehensive colleges indicated that the reason for a sizable proportion of their part-time hirings is to acquire the specialized background required for teaching certain courses, which is not available among the full-time faculty. Technical institutes were decidedly different in their responses. They less frequently reported excess e 4-8. Percent distribution of colleges' most important reasons for using part-time faculty, by reason and type of college

Reason	Type of college					Total
	Technical institutes	Private colleges	Small compre-hensive	Medium compre-hensive	Large compre-hensive	
ss of course sec-ons, insufficient to stify another full-me instructor	40	64	47	62	61	55
-time instructor not ailable	8	8	7	3	4	6
se requiring special-ed background not ailable among full-me faculty	4	6	19	9	7	9
ssary to save on sts of instruction	24	22	19	22	25	22
r	24	0	7	3	3	7

: Column sums may not total 100 because of rounding.

course sections as a reason (39 percent) than did the other types of colleges, and more frequently reported "Other" reasons. These "Other" reasons are 1) that regular faculty members are reluctant to teach evening courses, which are common in two-year colleges, and 2) that part-time faculty members come from industry and hence are more familiar with the latest developments in their fields.

The number of part-time faculty members was reported as the percent of all faculty members teaching in scientific fields. Table 4-9 shows this percent as a median for the five types of colleges. Although the median percent for all colleges is 20 percent, they range from 14 percent for the small comprehensive schools to 29 percent for large comprehensive institutions.

The percentage of class sections taught by part-time faculty, however, is not large, according to the administrators. Table 4-9 reports these percentages also as medians for the five types of colleges. For all colleges, the median percentage of class sections taught by part-time faculty is 11 percent, with large comprehensive schools reporting 16 percent and small comprehensive schools reporting 8 percent.

4.6 Student Needs

4.6.1 Basic Skills and Other Needs

Question: *[Five basic skills and 10 other needs] have frequently been identified as needs of students in two-year colleges. Identify those student needs that are of particular concern on this campus. (Rank . . . items according to their priority, beginning with 1 as highest.)*

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Table 4-9. Median percent of faculty that is part-time, and median percent of class sections taught by part-time faculty, by type of college

Type of college	Percent of part-time faculty*	Percent of class sections**
Technical institutes	27	9
Private colleges	18	9
Small comprehensive	14	8
Medium comprehensive	21	13
Large comprehensive	29	16
Total	20	11

*Each figure indicates the percent of part-time faculty employed by half or more of each type of college.

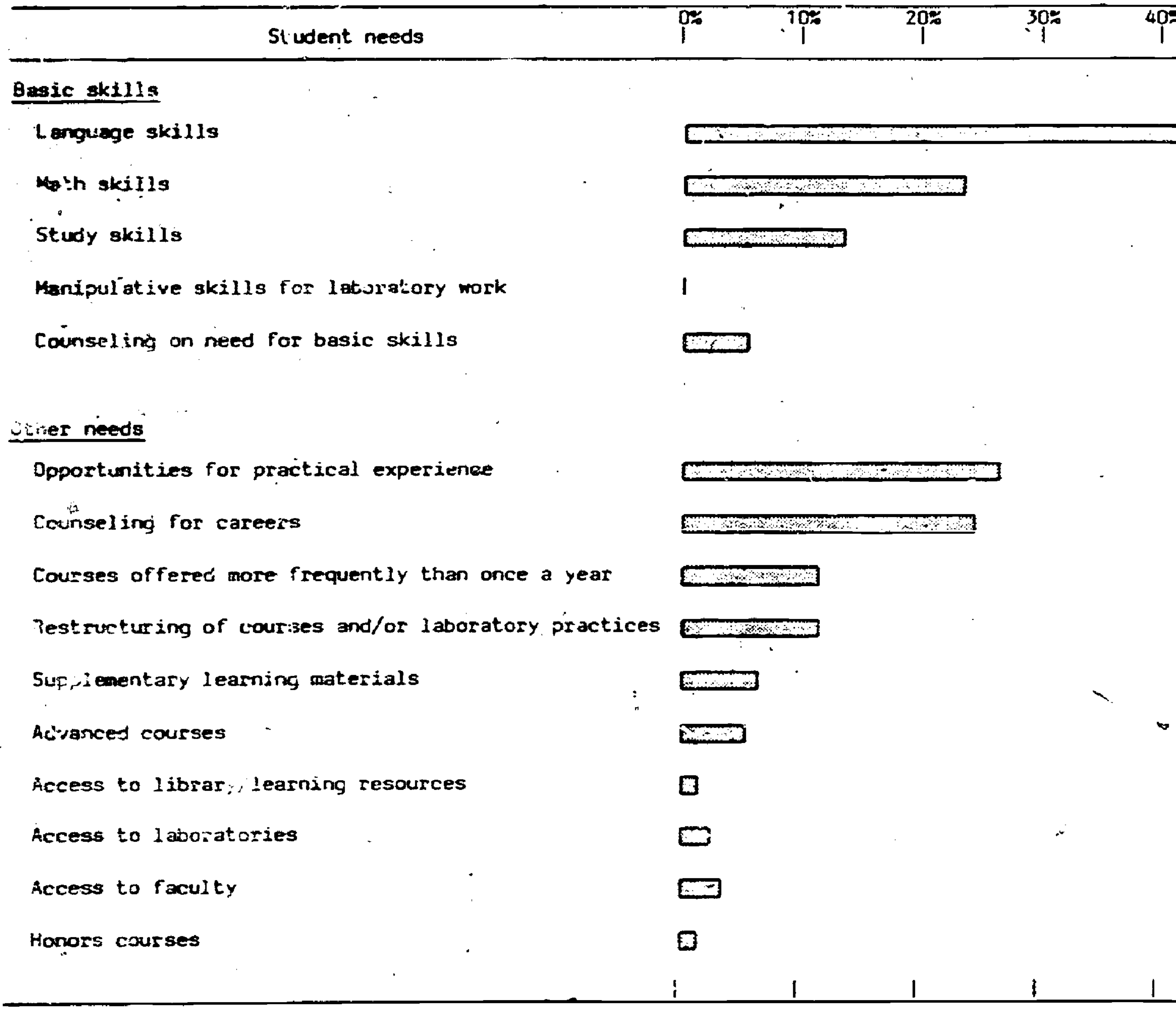
**Each figure indicates the percent of class sections taught by part-time faculty in half or more of each type of college.

As the question indicates, the needs of students were classified as two types -- basic skills and an assortment of other needs frequently requiring improvements. Most of the needs listed were mentioned by at least some of the administrators. Language and mathematics skills seem to cause nearly unanimous concern. Figure 4-6 shows the percent of college administrators indicating first priority for each need, for all colleges combined. Priorities were assigned separately to basic skills and to the other needs. Langauge skills received 56 percent of the administrators' first priority ratings among the basic skills, followed by mathematics skills (24 percent) and study skills (14 percent). The two most important of the other needs are opportunities for practical experience (27 percent) and counseling for careers (25 percent). Only small percents of the respondents assigned first priority to any of the other items.

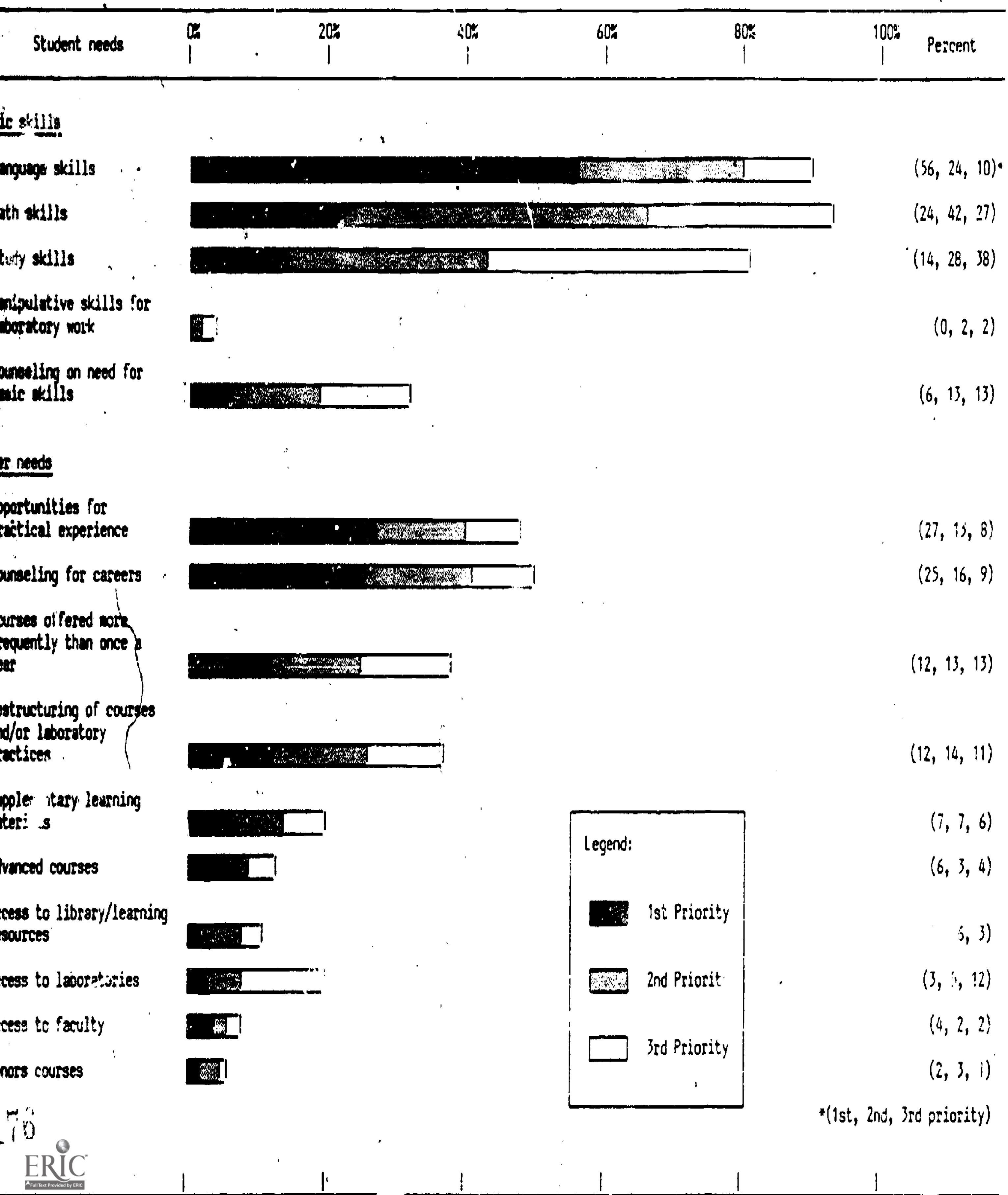
Figure 4-7 offers a comparison, for all colleges combined, of priority rankings for the basic skills and for the other needs. In this figure, priority 1, 2, and 3 rankings are shown. Clearly apparent is the dominant position given to language skills as a first priority However, the sum of the three priority levels shows that language, mathematics, and study skills all elicit major concern, receiving one of the top three priority rankings from 80 percent to 93 percent of the administrators.

Among the other needs, the sum of the top three rankings shows the importance given practical experience and career counseling; about 50 percent of the college administrators ranked both in the top three. Almost no support was indicated for advanced courses or for honors courses as priority items. Additional data on student needs, shown by type of colleges are located in Appendix D.

Figure 4-6. Percent distribution of administrators indicating h
student needs, by type of need



gure 4-7. Percent distribution of administrators indicating first, second, and third priority student needs, by type of need



4.6.2 <u>Encouraging Women, Minorities, and the Handicapped</u>

<u>Question:</u> *What methods does this college use to encourage the enrollment of the following student groups [women, minorities, handicapped] in science and technology? (Circle [any of seven alternatives, including 'Nothing special'] that apply.)*

Responses to this question were provided by utilizing a checklist of recommended practices for dealing with the special needs of these groups. The extent to which the colleges encourage the groups through application of these techniques is reported in Table 4-10.

Somewhat less than half of all colleges (46 to 47 percent) reported that attention is paid to recruiting women and minorities in the sciences and technology, while only 28 percent reported efforts for recruiting the handicapped. When specific measures were reported, about half of all colleges stated that they have both institutional policies and faculty sensitive to the needs of the three groups. However, special courses tailored to the needs of the groups and auxiliary personnel trained to assist them were less frequently mentioned.

Large differences occur among college types in this area. Consistently, for all three groups and for all items, the large comprehensive colleges lead the others, frequently by wide margins. With equal consistency, the small comprehensive schools are the lowest, sometimes by very wide margins, although on a few items the private colleges are almost as low.

One option that was checked about one-fourth of the time is 'Nothing special.' This response represents the opposite of positive measures, and its reported proportions are inversely

Table 4-10. Percent distribution of colleges reporting positive measures to encourage enrollments of three student groups in science and technology, by method of encouraging enrollment, student group, and type of college

WOMEN

Method	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive	Total
Recruitment	54	38	43	46	53	47
Special courses	28	12	2	45	48	29
Faculty sensitive to needs	73	42	23	50	74	50
Institutional policies	50	28	26	56	83	48
Auxiliary personnel	33	12	6	32	49	26
Nothing special	10	41	33	20	10	23
MINORITIES						
Recruitment	37	57	36	47	62	46
Special courses	24	10	0	29	42	21
Faculty sensitive to needs	47	51	33	47	69	48
Institutional policies	62	44	34	57	85	55
Auxiliary personnel	28	16	16	36	55	30
Nothing special	19	34	34	20	6	23
HANDICAPPED						
Recruitment	44	16	19	22	48	28
Special courses	23	0	7	19	29	16
Faculty sensitive to needs	57	32	16	41	65	43
Institutional policies	57	18	26	55	82	48
Auxiliary personnel	45	0	9	33	59	29
Nothing special	23	51	40	20	4	27

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related to the proportions of the positive measures for each of the college types. The exception is private colleges, which happen to have a high proportion of both women and black students in science courses, but which reported no unusual measures to recruit them.

> <u>Question:</u> *Has the college provided for <u>physical</u> access of handicapped students to science and technology classes?*

The replies to this question are shown in Table 4-11. About two-thirds of the colleges have provided partial physical access for the handicapped and another one-fourth, complete access. Private colleges are least in compliance, with about one-third reporting no provisions at all for access for handicapped students to physical facilities.

4.7 Unmet Needs: Programs Needed but Not Offered

> <u>Question:</u> *List the programs or curricula in science and technology <u>not</u> now offered on this compus for which a need has been identified in your community. Also indicate status of plans for introducing the program.*

The responses to this question may be viewed as indicators of the unmet program needs of two-year colleges, as distinquished from assessment of inadequacies in present programs. The fields that were listed most frequently are presented in Table 4-12. Once again, computer sciences head the list, with unspecified industrial and engineering technologies following. Programs in health-related occupations and in nursing are close behind. Specific technologies are led by chemical technology, electronics technology, and agricultural technologies.

e 4-11. Percent distribution of colleges providing physical access for handicapped students, by degree of access provided and type of college

ee of cess	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive	Total
lete	21	12	39	28	36	28
ial	63	54	61	70	64	64
at all	16	34	0	1	0	8

Table 4-12. Programs or curricula identified as needed but not now offered, by 10 educational fields most frequently mentioned: all colleges combined

Field	Number of times mentioned
Computer sciences	165
Industrial technologies, general	104
Engineering technologies, general	95
Health related occupations, general	94
Nursing	82
Chemical technology	73
Premed program	59
Electronics technology	55
Agricultural technology	54
Dental hygiene	52
All other fields combined	1,066
Total, all fields	1,899

For the broad curriculum areas, the technologies (both industrial and engineering) were mentioned 42 percent of the time by all schools combined, as shown in Table 4-13. Health-related occupations are a distant second, with 22 percent of the schools indicating a need for programs in this field. Unmet needs were not registered in the basic sciences, perhaps because they have been an integral part of college curricula since the beginning of the two-year college movement.

Table 4-13 also highlights similarities and differences among college types. The heavy emphasis on health- and technology-related occupations is especially evident among the small and medium comprehensive colleges. Large comprehensive institutions and technical institutes also indicated a sizeable need for technology programs.

Because of the large number of individual technologies that potentially could have been listed, the sum of these responses obscures the fact that the single most needed program is computer sciences (which was not included among the technologies). It leads the list for medium comprehensive and private colleges and is high in the rankings of other types of institutions.

The colleges also were asked to indicate the status of their plans for introducing new programs by checking one of the following:

- Definite plans exist;
- Plans are anticipated or under development, or
- No plans anticipated.

As shown in Table 4-14, the status of the colleges plans varies from little anticipated action among small comprehensive and private colleges, to more advanced planning among

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le 4-13. Programs or curricula identified as needed but not now offered; by broad curriculum area and type of college

Broad curriculum area	Type of college (percent of times mentioned)*					Total, all schools	
	Technical institutes	Private colleges	Small compre-hensive	Medium compre-hensive	Large compre-hensive	Number of times mentioned	Percent
iculture and natural esources	18	0	11	4	6	150	8
logical sciences	1	16	2	9	1	110	6
puter and information ciences	5	28	5	9	4	165	9
ineering	0	16	0	0	2	42	2
eral science and interdis-iplinary sciences	0	0	[illegible]	1	1	16	1
hematics	0	0	0	1	1	10	1
sing	1	14	5	4	3	82	4
sical sciences	0	8	5	3	6	72	4
ial sciences	4	0	5	1	1	47	2
hanical, engineering, atural science, and in-ustrial technologies	54	8	59	35	46	794	42
lth related occupations	17	10	5	34	27	411	22
al number of needed rograms	430	214	311	673	271	1,800	
rage number per college	1.9	1.3	1.2	1.6	1.7	1.5	

lumns may not total 100 because of rounding.

Table 4-14. Percent distribution of colleges indicating status of plans to develop needed programs or curricula, and number of programs needed, by type of college

Status	Type of college (percent)*					
	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive	Total
Definite plans exist	39	2	12	36	27	27
Plans are anticipated or under development	52	60	65	53	52	55
No plans anticipated	9	38	24	11	21	17
Number of programs needed	430	214	311	673	271	1,899

*Column sums may not total 100 because of rounding.

technical institutes and medium comprehensive schools. Private colleges are behind particularly in attempting to meet the needs that they identified; 38 percent indicated no plans at all for new programs.

4.8 Planning Process for New Courses or Programs

<u>Question</u>: *How many months does it usually take a proposal for a new course or program to gain approval through the college level (including board of trustees)?*

<u>Question</u>: *Once approval for a new course or program is gained at the college level, how many months does it take for any other approvals to be obtained?*

<u>Question</u>: *After gaining necessary approvals, how many months does it usually take before students are enrolled in the first class?*

How long it takes to obtain approval for a new course, and then how much longer until the material is actually presented to students in a classroom, is a topic of much interest in two-year colleges. Of even greater interest is the amount of time required to institute a new curricular program, which sometimes necessitates far-reaching changes in the structure of not only one department, but in other departments that must offer support services and courses, and in the college as a whole.

The approval process varies greatly among colleges. Internal administration procedures frequently are tied to faculty governance practices, with administration actions occurring both concurrently and consecutively with faculty procedures. With the large number of colleges dependent on state funds and state coordinating mechanisms, approval for new curricula is usually necessary at the state level as well. Funding for new courses or programs may be a separate issue from program approval; a proposal may be approved substantively, but not until fiscal plans are enacted can a college hire an instructor (or add to a faculty member's load), use classroom space, and so forth. In addition, there is the inevitable time lag between program approval and funding, and the enrollment of students in class.

Perhaps of greatest interest is the total length of time for the process. Table 4-15 presents estimates of the average number of months for each component of the process, then adds them to show the time lapse between the formal proposal and the start of actual instruction. For all colleges combined, the total time estimated for a new course from proposal to classroom is 9 months, and for a new curricular program, 18 months. Private colleges show the same length of time for new course development as the other school types but estimate about only one year for development of a new curriculum. Small comprehensive schools anticipate about a year for a new course and two years for a new curriculum. Administrators in technical institutes also estimate about two years for a new curriculum, although they allot less time for a new course.

Approvals at the local college level take more time than any of the other components -- as much as a year for new curricula in technical institutes and small comprehensive colleges. Approvals beyond the local level also take more time for technical institutes and small comprehensive schools than for other college types.

One important point must be noted. The process described above is merely the last stage in the development of a new course or curriculum. Before a proposal is submitted to begin the formal review process, a great deal of work usually has been done by faculty and often by administrative staff. A needs survey usually is taken at an early stage, once the basic idea

Table 4-15. Average number of months needed to gain approval for new courses and curricula, by type of college

Approval process	Type of college					
	Technical institutes	Private colleges	Small compre-hensive	Medium compre-hensive	Large compre-hensive	Total, all schools
Approval through the college level						
New course	3.6	4.2	5.1	3.4	5.1	4.1
New curriculum	11.7	6.9	11.0	7.4	10.0	9.2
Approval beyond the local college level						
New course	1.6	2.0	4.3	1.5	1.4	2.1
New curriculum	8.1	2.2	8.4	5.9	5.7	6.3
Time after approval until students are enrolled						
New course	2.7	2.7	2.2	3.1	3.4	2.8
New curriculum	6.0	3.8	4.0	6.0	5.1	5.1
Total time between initial proposal and enrollment of students in class (sum of above)						
New course	7.9	8.9	11.6	8.0	9.9	9.0
New curriculum	25.8	12.9	23.4	19.3	20.8	17.9

gains informal acceptance. Faculty members work to develop content and to determine feasibility, facilities, equipment, staff, and probable enrollment. Internal reviews usually are interposed at crucial check points. This development effort actually may take longer than the formal approval process. The real elapsed time between first discernment of a need (especially for a new curriculum) and its implementation in the classroom may well be double the time estimated in the responses to these questions.

4.9 Articulation with Four-Year Colleges

<u>Question:</u> *Does this <u>college campus</u> have <u>formal</u> arrangements with four-year colleges and/or universities for the transfer of credits?*

<u>Question:</u> *Rank the following [four] potential articulation problems for students transferring to four-year institutions from this college campus. (Begin with 1 as most important; if an item is not a problem, enter zero for the item.)*

<u>Question:</u> *Are courses in technology causing articulation problems different from those for science? If yes, please specify reasons.*

Two-year colleges have had problems, at least in the past, with the transfer of student credits to four-year colleges. As larger numbers of two-year colleges have been absorbed into state systems and into state coordination networks in higher education, these articulation problems appear to be diminishing. This series of questions was intended to examine the status of student credits transfer ability.

As Table 4-16 indicates, 80 percent of all colleges reported that they have formal arrangements with four-year institutions for the transfer of credits. The responses range from

Table 4-16. Percent distribution of colleges having formal credit transfer arrangements and experiencing articulation problems with four-year institutions, by articulation issue and type of college

Articulation issue	Type of college					
	Technical institutes	Private colleges	Small comprehensive	Medium comprehensive	Large comprehensive	Total
Formal arrangements to transfer credits (percent answering 'yes')	50	82	90	83	92	80
Potential articulation problems:						
Courses not accepted (percent answering 'important')	67	2	27	21	21	28
Courses not credited toward major requirements (percent answering 'important')	50	24	63	44	46	48
Courses considered upper division (percent answering 'important')	10	22	14	15	6	14
Courses considered remedial (percent answering 'important')	15	18	23	15	13	17
Technology courses cause problems (percent answering 'yes')	7	16	41	47	62	36

92 percent of the large comprehensive schools to 82 percent of the private colleges. The exception is technical institutes, with only 50 percent reporting formal arrangements. This last response is not surprising, since much of the curriculum in technical institutes is not intended for transfer to baccalaureate programs.

The most frequently reported problem is that receiving institutions accept science courses but will not credit them toward major requirements. Forty-eight percent of the schools view this problem as important, with 32 percent of them considering it their number one problem, and another 16 percent ranking it second. Technical institutes, however, reported that their greatest problem is that receiving institutions may not accept their courses at all.

As to whether problems arise over transfer of technology courses, the responses show that 62 percent of the large comprehensive schools, and well over 40 percent of both small and medium comprehensive colleges, experience such difficulties. The most prevalent reason is that courses in the technologies are not comparable to university courses and do not correspond with the core subjects (or even the specialties) that commonly apply to baccalaureate degrees. A physical science or math course given in the context of a specific technology simply is not transferable. Even four-year colleges specializing in technology impose difficulties in the transfer of two-year college courses because of the specificity of course content. One group in particular suffers from the lack of transferability -- the technology students who want to enter four-year programs in engineering, or less frequently, to enter one of the liberal arts or sciences. There is no comparability of courses for transfer of technology credits in such cases.

5. SCIENCE EDUCATION NEEDS IN TWO-YEAR COLLEGES: FACULTY PERSPECTIVE

5.1 Overview

Faculty members provided information on: 1) their personal experience and needs, and 2) needs in the educational fields in which they teach. They were requested to describe their past involvement in professional development activities and their present perceptions of their development needs. They identified student needs in two-year colleges. In addition, they evaluated the adequacy of their colleges' science education programs in their own fields and specified priorities for improving the programs at their institutions.

Data obtained from faculty members are presented in this chapter. The presentation is divided into sections, each beginning with the relevant question or questions from the faculty questionnaire, which is reproduced in Volume 2, Appendix E. Some of the more detailed data are located in Appendix D of Volume 2.

5.2 Past Involvement in Professional Development

5.2.1 NSF Programs

<u>Question:</u> *Have you been a participant in one or more <u>National Science Foundation</u> institutes or other programs sponsored by NSF?*

If you answered yes [to the above question], please complete the table below, . . . [indicating those in which you participated <u>prior to 1970</u> and <u>since 1970</u>.

From the late 1950s to the middle 1970s, the National Science Foundation supported a major education program for teachers of mathematics and the sciences. While this program was directed primarily to secondary school teachers, a considerable number of two-year college teachers also participated. Moreover, a rather large percentage of two-year college science teachers originally were high school teachers. Followup studies of NSF institute participants revealed that many who received graduate degrees in the sciences through NSF institutes became two-year college faculty members. Altogether, by the early 1970s, it is estimated that about half of all high school science and mathematics teachers had participated in at least one NSF institute during their teaching careers.

The importance of NSF institutes and fellowships lies in the emphasis placed on the subject matter of the disciplines they covered. The increased qualifications of institute graduates made them prime candidates for two-year college science departments, which during the early 1960s were recruiting at a frantic pace to fill staff positions in newly built community colleges. Two-year colleges thus were able to maintain high faculty academic standards and at the same time build up staffs of experienced teachers.

Faculty responses to the above questions are shown in Table 5-1 for full-time and part-time faculty by college type and educational field. Overall, about 30 percent of full-time faculty and 16 percent of part-time faculty participated in one or more NSF programs. The largest percentages of full-time faculty indicating participation in these programs are in mathematics (58 percent), physical sciences (57 percent), and introductory biology (50 percent). Also of interest is the high participation rate of part-time faculty in the same educational fields: 51 percent for mathematics, 55 for introductory biology, and 31 percent for physical sciences. The fields showing lower full-time faculty participation rates are: the social sciences (20 percent), engineering

Table 5-1. Percent distribution of faculty who have participated in one or more National Science Foundation institutes or other programs, by type of college, educational field, and full-/part-time status

	Status	
	Full-time	Part-time
Type of college		
Technical institutes	20	14
Private colleges	39	17
Small comprehensive	44	7
Medium comprehensive	33	23
Large comprehensive	28	9
Total	30	16
Educational field		
Introductory biology	50	55
Health sciences	3	0
Other life sciences	39	13
Physical sciences	57	31
Engineering and technology	19	0
Mathematics	58	51
Computer sciences	10	27
Social sciences	20	3
Total	30	16

and technology (19 percent), computer sciences (10 percent), and health sciences (3 percent). By college type, the largest proportions of full-time faculty with NSF program backgrounds are from small comprehensive schools (44 percent) and private colleges (39 percent).

The specific types of programs in which these faculty members participated are listed in Table 5-2 separately for full- and part time faculty, by educational field. The proportions of particip s before 1970 and since that year indicate how recent faculty involvement in these sources of self-improvement has been.

Of the full-time faculty, a substantial proportion now teaching introductory biology, physical sciences, and mathematics in two-year colleges has participated in summer institutes. Those in the same fields also have participated frequently in academic year institutes. Science facu ty fellowships were reported by those now teaching introductory biology and physical sciences. Participation in Chautauqua conferences has been distributed fairly evenly among those teaching in the traditional four-year college disciplines (introductory biology, other life sciences, physical sciences, mathematics, and social sciences). Except for the Chautauqua conferences and in-service institutes, involvement in improvement activities since 1970 is lower than before that year.

The participation patterns of part-time faculty roughly parallel those of full-time faculty for summer institutes in four fields: introductory biology, mathematics, physical sciences, and other life sciences.

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Table 5-2. Percent distribution of faculty participating in NSF programs, by type of program, educational field, and full-/part-time status

Type of program and status	Educational field								Total	
	Intro-ductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathe-matics	Computer sciences	Social sciences	Before 1970	1970 and later
Summer institutes										
Full-time	43	1	25	42	11	50	0	10	12	8
Part-time	55	0	13	20	0	49	0	0	7	3
Academic year institutes										
Full-time	33	0	2	15	2	13	0	1	5	1
Part-time	0	0	0	6	0	11	0	0	0	2
In-service institutes										
Full-time	8	2	9	15	5	15	0	2	4	4
Part-time	0	0	0	6	0	6	0	0	1	1
Science faculty fellowships										
Full-time	18	0	0	12	3	2	0	1	2	1
Part-time	55	0	0	0	0	0	0	0	0	1
Chautauqua conferences										
Full-time	13	0	12	14	4	9	0	7	-	8
Part-time	0	0	0	0	0	0	0	0	-	0
Other										
Full-time	5	0	2	6	3	6	0	1	1	1
Part-time	0	0	0	0	0	3	0	7	2	1

5.2.2 Programs Not Supported by NSF

<u>*Question:*</u> *Since 1970, have you participated in professional development programs or activities not supported by the National Science Foundation?*

If you answered YES . . ., please [indicate the types of programs].

Nearly two-thirds of all full-time faculty in the study and nearly one-half of the part-time faculty reported participating since 1970 in programs not supported by NSF. Table 5-3 shows the extent of this kind of participation by college type and educational field. For all subgroups the participation rate is high. Only the full-time faculty in small comprehensive schools falls below 50 percent; part-time faculty in these colleges, however, participated at a rate of 72 percent. The participation rates among full-time faculty do not vary greatly by educational field. They only range from 69 percent of the faculty in engineering and technology to 51 percent of the faculty in introductory biology. For part-time faculty the variation is greater. Other life sciences show a high of 86 percent participation, and mathematics faculty are the lowest with 31 percent.

The types of programs attended by faculty members are summarized in Table 5-4. Attendance rates for institutes or extended conferences sponsored by scholarly groups (39 percent of the full-time faculty) exceed by a considerable margin the same kinds of programs sponsored by Federal agencies or private industry. Next most often mentioned (37 percent) is formal course work at colleges or universities at the individual's own expense, an important option for all educational fields. Twenty-two percent of full-time faculty, led by those in engineering and technology and computer sciences, reported practical work experience in relevant fields. The programs attended by part-time faculty

Table 5-3. Percent distribution of faculty participating since 1970 in professional development programs not supported by NSF, by type of college, educational field, and full-/part-time status

Type of college and educational field	Status	
	Full-time	Part-time
Type of college		
Technical institutes	58	51
Private colleges	55	36
Small comprehensive	44	72
Medium comprehensive	68	51
Large comprehensive	66	42
Total	63	48
Educational field		
Introductory biology	51	54
Health sciences	58	43
Other life sciences	68	86
Physical sciences	63	58
Engineering and technology	69	45
Mathematics	60	31
Computer sciences	57	64
Social sciences	61	46
Total	63	48

Table 5-4. Percent distribution of faculty participating in non-NSF programs since 1970, by type of program, educational field, and full-/part-time status

Type of program and status	Educational field								Total
	Introductory biology	Health sciences	Other life sciences	Physical sciences	Engineering and technology	Mathematics	Computer sciences	Social sciences	
Institutes or extended conferences sponsored by a Federal agency other than NSF									
Full-time	24	18	9	23	10	7	24	13	15
Part-time	0	17	0	14	4	2	0	12	9
Institutes or extended conferences sponsored by industry or a private foundation									
Full-time	22	26	21	16	25	8	28	12	18
Part-time	55	26	13	12	28	20	0	21	22
Institutes or extended conferences sponsored by professional associations or other scholarly groups									
Full-time	30	53	47	29	28	26	33	38	39
Part-time	55	43	72	40	24	7	0	30	32
Formal course work at a college or university independent of outside sponsorship									
Full-time	13	40	38	35	28	41	27	41	37
Part-time	55	0	73	14	21	5	50	19	19
Self-study courses									
Full-time	3	24	12	18	21	18	21	7	15
Part-time	0	0	0	9	16	9	0	15	11
Practical work experience in a relevant field									
Full-time	21	24	19	16	36	6	38	26	22
Part-time	55	17	59	19	31	8	0	9	20
Other									
Full-time	3	1	5	6	6	2	10	4	4
Part-time	0	0	28	2	7	0	0	2	4

Note: Percentages total more than 100 because of multiple responses.

members are roughly the same as those attended by full-time faculty, although there is wider fluctuation by educational fields.

It is not possible from these data to determine the depth or intensity of the kinds of activities engaged in. The activities may range from two- or three-day conferences to several weeks of intensive study, or from study of the content of a discipline to teaching methodologies. However, an attempt to examine this issue was made by asking faculty the following question:

> <u>*Question:*</u> *[Was] a substantial part of this program . . . in the field of your current teaching assignment?*

The majority of respondents stated that the content was related to their teaching assignments, usually well over 70 percent of the time and up to 90 percent of the time. The only exception to this trend is formal course work at the individual's own expense; only 22 percent of the full-time faculty considered the course content related to their teaching assignments.

5.3 Needs for Further Professional Development

> <u>*Question A:*</u> *Are there substantial portions of this course for which you feel you could be more adequately prepared?*

Of the full-time faculty, 31 percent answered that there was at least one course they were teaching for which they felt the need for substantially more preparation. The range by college type is from 21 percent for private colleges to 43 percent for small comprehensive schools, and by educational field from 24 percent in mathematics to 39 percent in computer sciences. Part-time faculty answered yes to this question 24 percent of the time, with very wide variation by college type and educational field. Table 5-5 presents these data.

> *Question B:* *For your current teaching assignment, are there areas or topics in science or applied science in which you feel the need for further professional development?*

This question asks for similar information, but in another context. As shown in Table 5-6, the proportion answering yes is about twice as high as for Question A for full-time faculty and fifty percent greater for part-time faculty. In the computer sciences, 81 percent of the full-time faculty stated that they felt this need, while the responses of faculty in the social sciences are low, with 47 percent responding affirmatively. Of the faculty respondents in private colleges, 51 percent answered in the affirmative, the lowest percentage among all college types.

> *Question C:* *List the programs you feel you need for your professional development.*

This free-answer question permitted up to five responses. The replies, presented in Table 5-7, are of two kinds. The first is a list of specific or general course titles (e.g., chemistry, biological sciences), and the other is a list of general topics, such as more advanced or specialized courses, or updating education. These responses are presented separately according to frequency of mention; the first on the list is the one that was listed by the largest number of faculty members.

It is evident that subject areas in science or technology were clearly on the minds of most respondents. Education as a discipline received only five percent of the responses, and

Table 5-5. Percent distribution of faculty indicating need for substantial preparation in at least one course taught, by type of college, educational field, and full-/part-time status

Type of college and educational field	Status: Full-time	Status: Part-time
Type of college		
Technical institutes	39	40
Private colleges	21	38
Small comprehensive	43	7
Medium comprehensive	30	20
Large comprehensive	26	24
Total	31	24
Educational field		
Introductory biology	32	0
Health sciences	35	15
Other life sciences	35	14
Physical sciences	29	38
Engineering and technology	29	18
Mathematics	24	10
Computer sciences	39	37
Social sciences	28	32
Total	31	24

Table 5-6. Percent distribution of faculty indicating need for professional development, by type of college, educational field, and full-/part-time status

Type of college and educational field	Status	
	Full-time	Part-time
Type of college		
Technical institutes	56	24
Private colleges	51	25
Small comprehensive	66	52
Medium comprehensive	69	38
Large comprehensive	56	34
Total	61	35
Educational field		
Introductory biology	69	55
Health sciences	71	53
Other life sciences	77	74
Physical sciences	55	27
Engineering and technology	59	26
Mathematics	51	21
Computer sciences	81	27
Social sciences	47	38
Total	61	35

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Table 5-7. Relative frequency of facility choices of programs needed for further professional development, by type of course and topic mentioned: all faculty combined

Type of course and topic	Relative frequency (percent)
General and specific courses, by broad field, in rank order	
Biological sciences	23.3
Social sciences	9.4
Physical sciences	8.6
Computer sciences	7.2
Technologies	7.2
Agriculture	5.1
Education	5.0
Health related fields	4.3
Mathematics	3.7
Nursing	3.3
Nonscience subjects	2.8
Research in science	1.4
Engineering	1.0
General topics, in rank order	
Update education	11.2
Professional conferences and conventions	2.9
More advanced, specialized courses	2.4
Curriculum development	1.1
Sabbatical and study leave	.3
Total number of responses	35,325

nonscience subjects such as business and accounting received only three percent. The remaining responses are definitely in the sciences. These course needs obviously are related to areas in which faculty members are teaching. The many courses listed in biological sciences are useful to teachers in several fields; those in mathematics may serve faculty in any of the physical sciences and technologies. Physical science courses are basic to many other fields. Computer science courses are, of course, useful in any of the science or technology areas.

> <u>*Question D:*</u> *[If you do not plan to participate] in any of the programs you listed [in Question C above], what are your reasons for not planning to take this program in the next year or two?*

Table 5-8 shows the various reasons given by those faculty respondents whose needs will not be fulfilled in the next year or so. Personal cost and a full schedule are the most frequent responses by full-time faculty, followed by travel distance and conflicts in schedule. Part-time faculty responded at a lower percentage rate, with a full schedule being identified as their most important reason for not participating.

5.4 Use of Part-Time Faculty

> <u>*Question:*</u> *What is the approximate percent of course sections taught by part-time faculty on this campus <u>in your teaching field(s)</u>?*

> <u>*Question:*</u> *How do you feel about the proportion of course sections taught by part-time faculty on this campus in your teaching fields(s)?*

The use of part-time faculty may be required for several reasons, as discussed in Section 4.5. Depending on situations in

Table 5-8. Percent distribution of faculty desiring professional development programs but not planning to participate, by reasons for not participating and full-/part-time status

Reason for not participating	Status	
	Full-time	Part-time
Intend to take an alternative education program	3	3
Quality of program is unsatisfactory	3	1
Program offered too far away	12	5
Personal cost to me would be too great	16	6
My schedule will be too full	15	11
My college schedule or my other responsibilities conflict with the hours the program is offered	13	3
The college would not allow release or compensatory time to attend	6	1
Other	1	0

individual colleges, the reliance on part-time faculty may be viewed by full-time faculty members as either beneficial or detrimental to the educational program as a whole. Faculty members' perceptions of the use of part-time teachers and their attitudes toward this practice are explored in responses to these questions. Results may be compared with administrator responses.

Table 5-9 shows faculty estimates of the proportions of class sections taught by part-time faculty. Full- and part-time faculty estimates are shown separately. There is obvious discrepancy between the estimates of the full- and part-time faculty respondents, both by college type and by educational field. Part-time faculty members estimated that nearly twice as many course sections are taught by part-time faculty as are taught by full-time faculty.

Attitudes toward the perceived proportion of course sections taught by part-time faculty are shown in Figure 5-1, separately for full- and part-time faculty. Full-time faculty members in all instances tended to rate the proportion of class sections taught by part-time faculty as slightly too high. However, part-time faculty in general tend to believe the proportion of courses taught by part-timers is closer to the "about right" category. In fact, part-time faculty members in small comprehensive schools, and in health and computer sciences, believe that the proportion of course sections taught by part-time faculty is slightly too low.

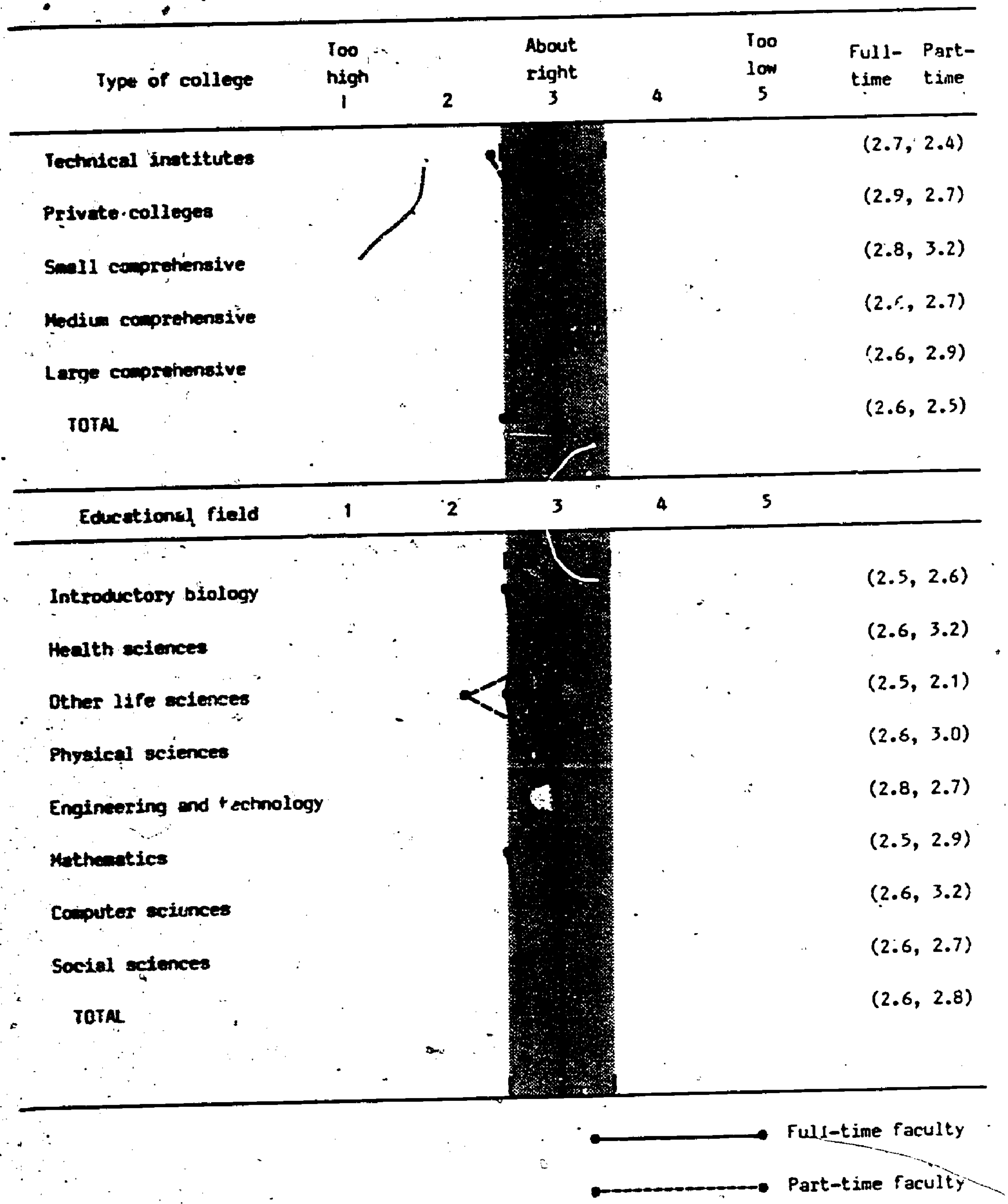
5.5 Faculty Participation in the Planning Process

Question: *In general, for individual courses on this campus, what degree of responsibility does a member of the full-time faculty have for the following [seven] planning elements?*

Table 5-9. Faculty estimates of percent of all class sections taught by part-time faculty (average percentage), by type of college, educational field, and full-/part-time status

Type of college and educational field	Status	
	Full-time	Part-time
Type of college		
Technical institutes	15	27
Private colleges	18	26
Small comprehensive	12	29
Medium comprehensive	20	36
Large comprehensive	23	42
Total	19	36
Educational field		
Introductory biology	19	21
Health sciences	21	40
Other life sciences	13	43
Physical sciences	17	25
Engineering and technology	24	46
Mathematics	23	36
Computer sciences	29	18
Social sciences	21	33
Total	19	36

Figure 5-1. Faculty members' attitudes toward perceived proportion of course sections taught by part-time faculty, by type of college, educational field, and full-/part-time status



<u>Question</u>: In general, for a <u>curricular program</u>, as opposed to an individual course, what degree of responsibility does a member of the full-time faculty on this campus have for the following [four] planning elements?

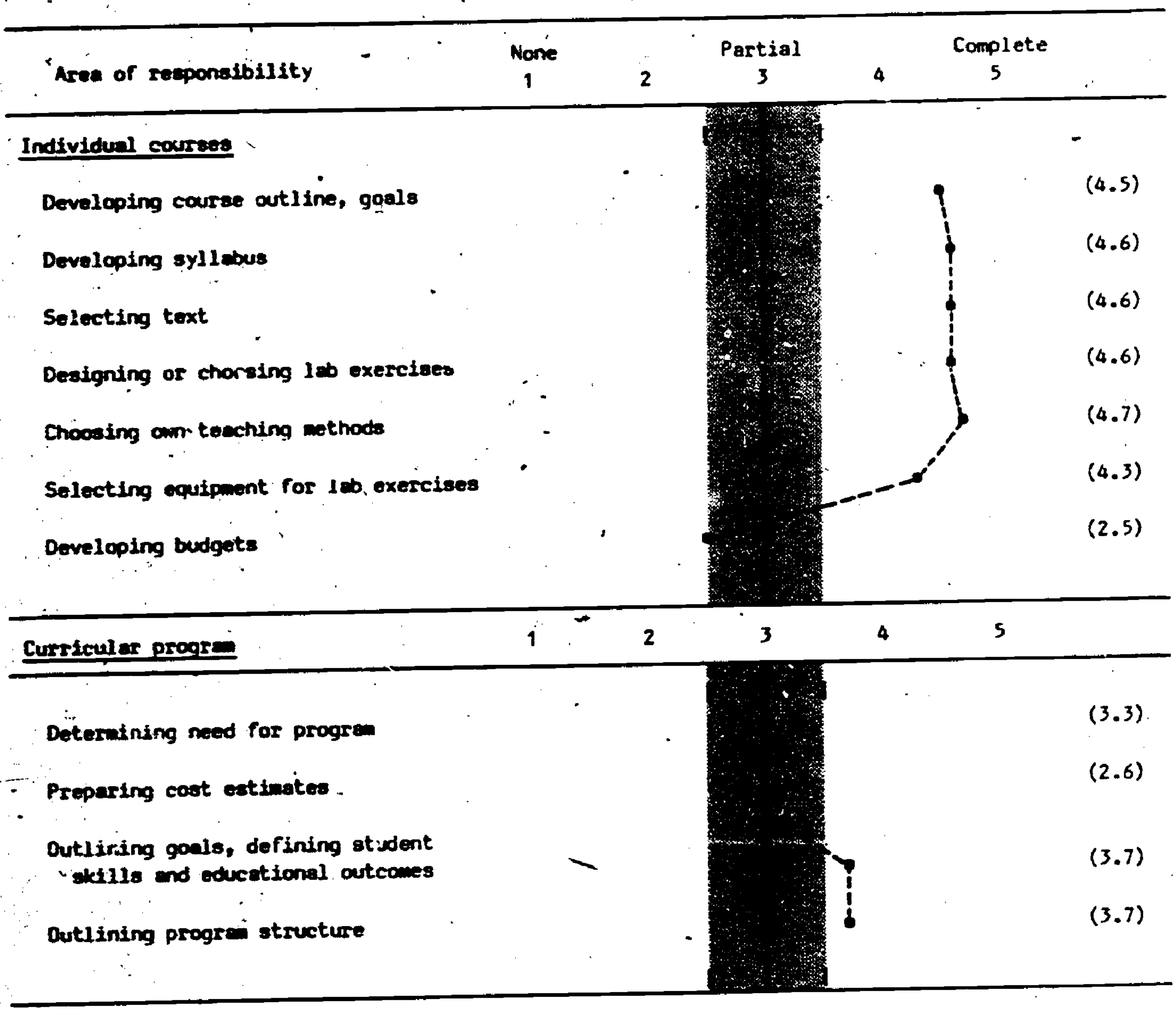
Traditionally, college faculty members play important roles in the processes of educational planning. These two questions were intended to ascertain how much responsibility two-year college faculty members have in the various aspects of educational planning in the sciences and technology, both for individual courses and for more complex curricular programs.

Estimates of degree of faculty responsibility were obtained by ratings on a five-point scale, ranging from complete responsibility to no responsibility at all. The data in general show that faculty members view themselves as playing important roles in developing new programs, as well as having a great deal of freedom in the planning of their individual courses. Average ratings of responsibility for each planning activity for individual courses and curricular programs are given in Figure 5-2. Only the average ratings for all faculty combined are shown because there was extremely little variation by educational field or college type.

The responses clearly show that two-year college faculty members have a very central role in the planning and development of individual courses. For all activities except developing budgets, they indicated close to complete responsibility. Budget development falls well below the midpoint level.

The pattern for developing and planning new curricular programs, however, is somewhat different than that for individual courses. The overall level of faculty responsibility is lower, and in one of the most critical areas -- determining the need for

Figure 5-2. Faculty members' estimates of the degree of their responsibility for planning individual courses and curricular programs: average ratings, by area of responsibility



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a program -- it is only slightly above the midpoint level of partial responsibility.

> <u>*Question:*</u> *Have you participated in the planning of an <u>individual course</u> in this college?*
>
> <u>*Question:*</u> *Have you participated in planning a <u>curricular program</u> in this college?*

As Table 5-10 shows, 92 percent of the full-time faculty and 50 percent of the part-time faculty, have actually participated in the planning of individual courses at their colleges. For large comprehensive colleges, this figure is 98 percent of the full-time faculty. By educational field there is little variation in the high percentage of full-time faculty participation, although for the part-time faculty the extent of participation varies greatly with the field, ranging from 14 percent for other life sciences to 82 percent for introductory biology. Participation in the planning of new curricular programs was reported by 63 percent of the full-time faculty and 26 percent of the part-time faculty.

5.6 Student Needs

5.6.1 Basic Skills and Other Needs

> <u>*Question:*</u> *[Five basic skills and ten other needs] have frequently been identified as needs of students in two-year colleges. Identify those student needs that are of particular concern on this campus. (Rank . . . items according to their priority, beginning with 1 as highest.)*

This question is identical to the one asked of administrators in the institutional questionnaire. As shown in Figure 5-3, language skills are given first priority by 40 percent of

Table 5-10. Percent distribution of faculty participating in development of new courses and curricular programs, by type of college, educational field, and full-/part-time status

Type of college and educational field	Status			
	New courses		New curricula	
	Full-time	Part-time	Full-time	Part-time
Type of college				
Technical institutes	87	60	59	44
Private colleges	84	57	47	37
Small comprehensive	83	33	59	0
Medium comprehensive	93	53	65	29
Large comprehensive	98	46	68	19
Total	92	50	63	26
Educational field				
Introductory biology	93	82	31	0
Health sciences	91	75	72	43
Other life science	97	14	67	0
Physical sciences	87	40	46	8
Engineering and technology	91	56	74	32
Mathematics	91	24	44	8
Computer sciences	100	27	68	0
Social sciences	93	57	73	39
Total	92	50	63	26

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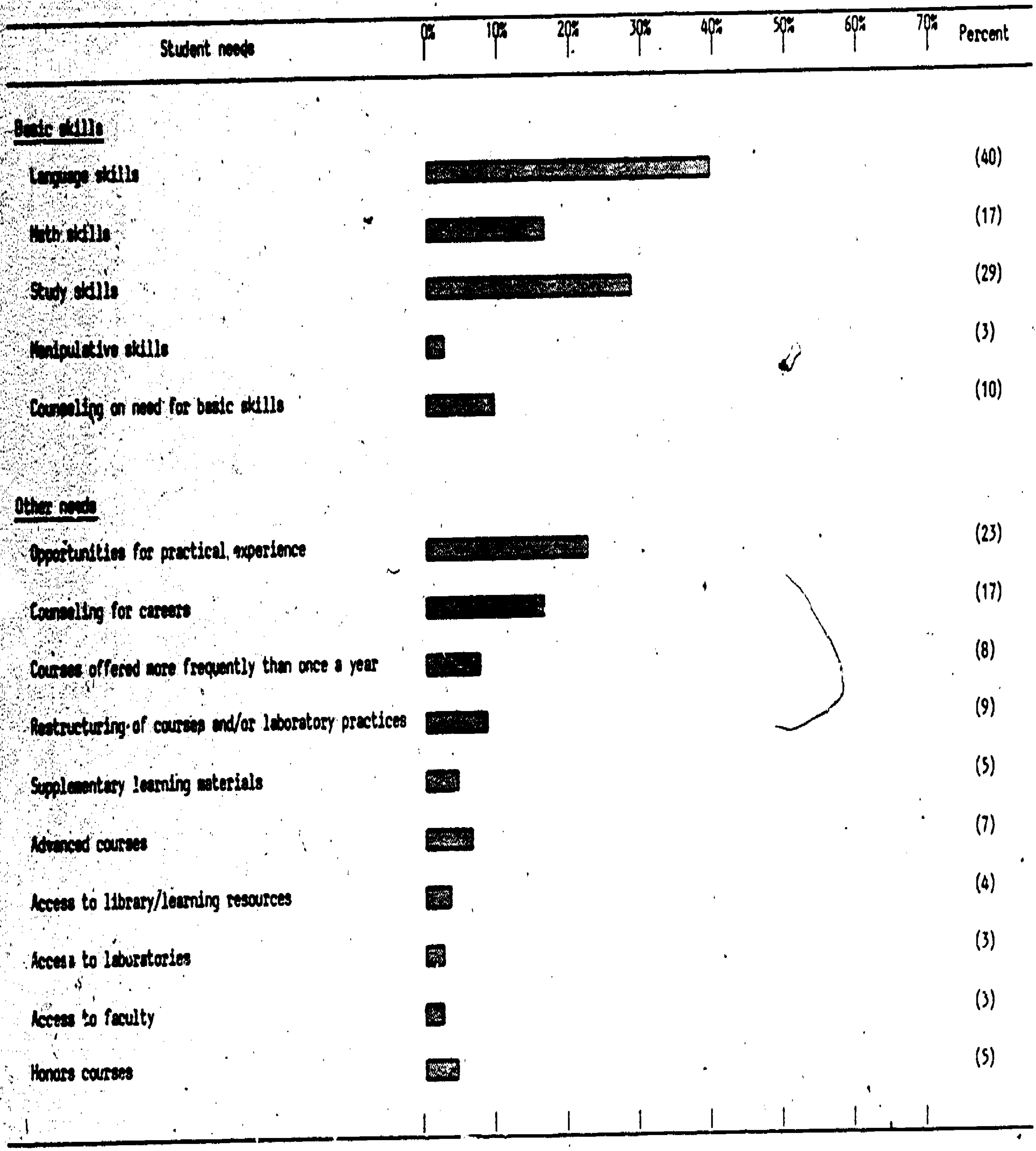
Figure 5-3. Percent distribution of faculty indicating highest priority student needs, by type of need



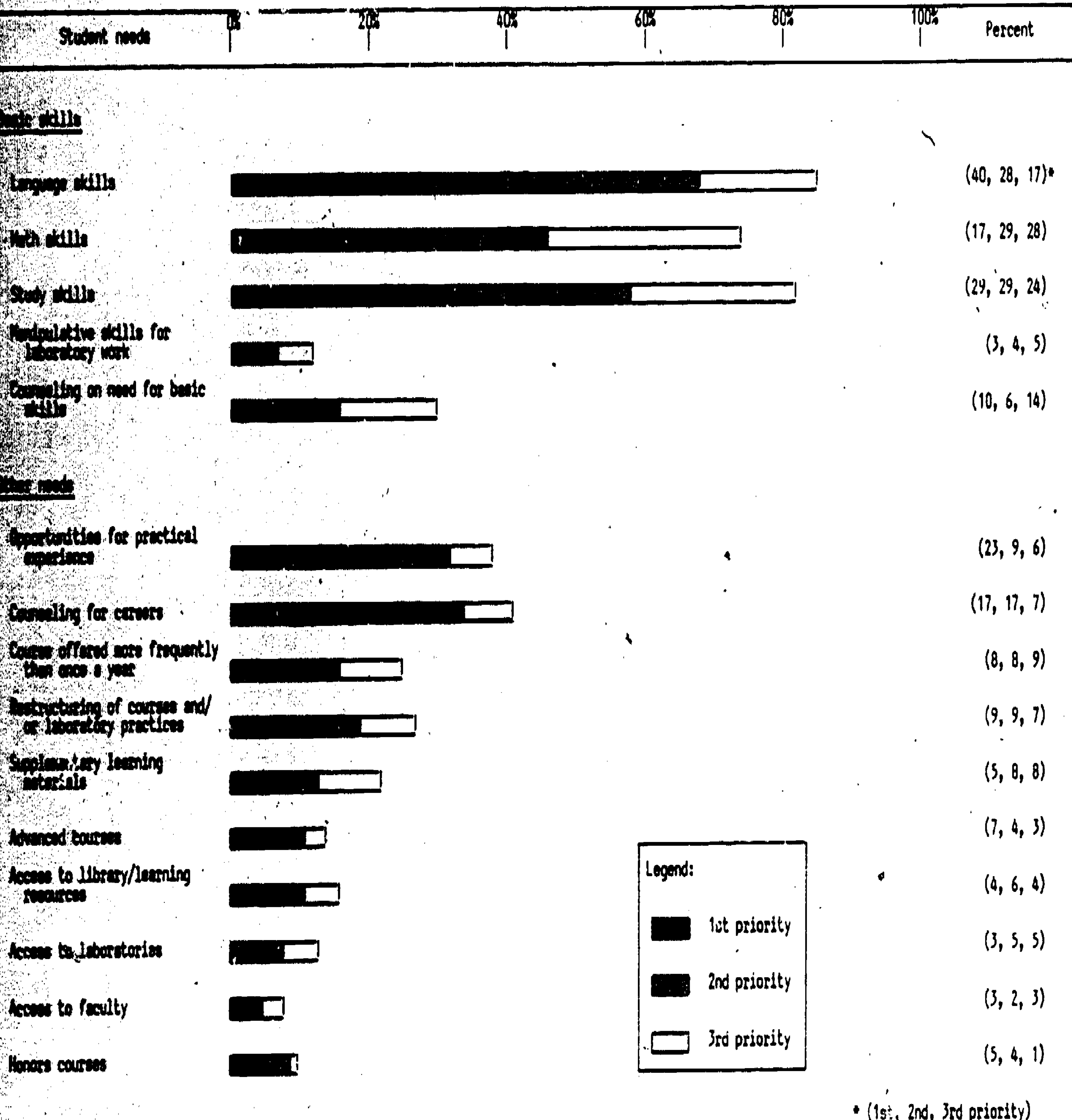
the faculty, math skills by 17 percent, and study skills by 29 percent. As noted in Chapter 4.6, the administrators reversed the order for the last two. Among the other needs, practical experience is viewed by faculty members as most important, followed by counseling for careers, the same order of first priorities as the administrators'.

More detailed information on faculty estimates of student needs, by type of college and by educational field, appears in Appendix D. These appendix figures show that a considerable variation in the first priority rankings exists among the various college types and educational fields. For example, language skills are of most concern to small comprehensive colleges, but of least concern to technical institutes. Math skills are assigned first priority most often by technical institutes but least often by private colleges. Study skills are a shared concern among all college types, but most frequently among private colleges. Of the other needs, practical experience is a first priority of technical institutes (34 percent) by a considerable margin over other types of colleges. Offering courses more than once a year seems more important to private colleges than to the others.

Another perspective is gained by comparing the priority rankings of the faculty for each item. Figure 5-4 shows, for all faculty members combined, the priority ratings 1, 2, and 3 for each item. The relative importance of the basic skills as first priorities is thus illustrated. When priorities 2 and 3 are added, the cumulative importance of language, math, and study skills is clearly illustrated.

When these data are viewed by college type and educational field, differences among important subgroups of faculty emerge. Two groups of figures in Appendix D show detailed data

Figure 5-4. Percent d[illegible]ution of faculty indicating first, second, and third priority student needs, by type o[illegible]



by college type and educational field. From these charts, it is evident that technical institute faculty members consider language, math, and study skills as being of nearly equal importance, not as first priorities alone, but cumulatively (first, second, and third priorities combined); 80 percent or more of these faculty members assigned one of the top three priorities to each of these skills. None of the other college types ranks math skills as highly.

Variations among the educational fields in first priorities and the sums of priorities 1, 2, and 3 also are shown in the appendix tables. The contrast in outlook between those who teach engineering and technology and those who teach introductory biology is great. The technologists emphasize math skills and practical experience; the biology teachers focus on language and study skills, plus career counseling, more advanced courses, and courses scheduled more frequently than once a year.

5.6.2 Encouraging Women, Minorities, and the Handicapped

Question: *What does this college do to encourage the enrollment of the following student groups [women, minorities, and handicapped] in science and technology?*

This question also appears in the institutional questionnaire. Results for all full-time faculty, all fields combined, are presented in Table 5-11. Detailed tables for full-time faculty responses, by college type and educational field, are in Appendix D.

About 60 percent of the faculty respondents reported active recruitment in their colleges of women and minority groups, and 46 percent reported recruitment of the handicapped. The majority of these respondents also indicated that faculty members

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Table 5-11. Percent distribution of faculty reporting positive measures to encourage enrollment of women, minorities, and the handicapped, by type of measure and student group: all full-time faculty combined

Type of measure	Student group		
	Women	Minorities	Handicapped
Recruitment directed toward the groups	60	62	46
Special courses	42	39	27
Faculty sensitive to the needs of the group	65	67	62
Institutional policies and procedures	50	55	54
Auxiliary personnel trained to assist	33	42	40

Note: Totals do not add to 100 percent because of rounding.

are sensitive to needs of the three groups (62 to 67 percent) and that their colleges have institutional policies to encourage their enrollment (50 to 54 percent). However, faculty are less positive about special courses and auxiliary personnel employed to assist those groups.

When the data are analyzed by college type and educational field (see Appendix D), it is found that small comprehensive colleges are somewhat less active than other schools in recruiting women, minorities, and the handicapped. Small comprehensive colleges also make less effort to develop appropriate institutional policies and procedures. In contrast with small comprehensive schools, the large comprehensive colleges tend to be most active in encouraging and assisting these three groups of students. Overall, the area perhaps most in need of attention is trained auxiliary personnel; very small percentages of faculty in both private colleges and small comprehensive schools reported adequate personnel for assisting women, minorities, and the handicapped.

<u>Question</u>: *Has the college provided for <u>physical</u> access of handicapped students to science and technology classes?*

Responses to this question for all full-time faculty are given in Table 5-12, and by college type and educational field in Appendix D. Complete access of the handicapped to science and technology classes was claimed by 44 percent of the faculty respondents, with another 52 percent reporting partial access. Only 5 percent answered that no access at all is available. Most of the 'not at all' responses came from private colleges (34 percent), exactly the same percentage given by private college administrators.

Table 5-12. Faculty assessment of provisions for physical access of the handicapped to science and technology classes: all full-time faculty combined

Degree of access	Percent*
Completely	44
Partially	52
Not at all	5

*Total does not add to 100 percent because of rounding.

5.7 Adequacy of College Science Education

Question: *Rate [19] institutional characteristics in terms of their adequacy to support the science course(s) that you are teaching at this campus.*

Faculty members were asked to rate the adequacy of their science programs on each of the 19 institutional characteristics listed in this question. Respondents used a five-point scale ranging from 'excellent' to 'totally inadequate,' with the midpoint indicating 'adequate.' The average mean ratings for all faculty members combined are presented in Figure 5-5. This figure also shows the high and low ratings for each item. Additional detailed figures showing responses to this question for each institutional characteristic, by college type and educational field, are included in Appendix D.

The most obvious pattern of the ratings is that they tend to cluster around the midpoint. If a rating of 'adequate' gure 5-5. Faculty assessment of 19 institutional characteristics: average ratings, by institutional characteristic

Rating scale: Totally inadequate 1 — 2 — Adequate 3 — 4 — Excellent 5

Institutional characteristics	Low	Mean	High
Course structure	3.2	3.9	4.1
Classroom/lecture facilities	3.2	3.6	3.9
Class preparation areas	3.0	3.4	3.8
Lecture-demonstration facilities	3.1	3.5	3.6
Laboratory facilities (space)	2.9	3.3	3.5
Laboratory apparatus and equipment	2.8	3.1	3.3
Budget for laboratory equipment and supplies	2.5	2.7	3.0
Laboratory usage	3.0	3.6	3.8
Instructional technicians (laboratory aides) - quantity	2.3	2.5	2.8
Instructional technicians (laboratory aides) - quality	2.5	3.0	3.2
Availability of teaching aids	2.9	3.5	3.7
Size of classes	3.3	3.5	3.7
Prior preparation of students	2.3	2.6	2.9
Clerical support	2.5	3.1	3.6
Library	3.2	3.6	3.7
Availability of professional journals	2.9	3.3	3.6
Opportunities for professional growth	2.7	3.0	3.1
Teaching environment	3.4	3.7	4.0
Articulation with transfer institutions' policies on transfer of credits	2.9	3.4	3.7

can be regarded as neither praise nor condemnation, then on most items and for most faculty members, conditions meet minimum expectations. However, several characteristics received high approval by faculty. They are course structure, teaching environment, classroom/lecture facilities, laboratory usage, and library. Faculty members are least satisfied with prior preparation of students, quantity of laboratory aides, and budget for laboratory equipment and supplies. These last three characteristics were rated sufficiently low that they can be considered generally inadequate, regardless of college type or educational field.

A more detailed view of the reactions of faculty from the several types of colleges and educational fields is provided in Figures 5-6 and 5-7. The most striking feature of these profiles is the great similarity of high and low points. General agreement exists among faculty in all types of colleges and in all educational fields as to which are the best and which are the poorest characteristics.

Among the college types, faculty members in technical institutes and private schools tended to give lower ratings on more institutional characteristics than did faculty in medium and large comprehensive schools. Technical institute and private college faculty members are less satisfied than faculty in the public comprehensive colleges with their laboratory facilities, laboratory apparatus, and clerical help. Small comprehensive school faculties rated their opportunities for professional growth as rather inadequate. On the other hand, both small comprehensive and private college facilities gave the highest ratings for teaching environment.

When shown by educational field, the data indicate that faculty members teaching in the computer sciences are the least satisfied with the 19 institutional characteristics of their

Figure 5-6. Faculty assessment of 19 institutional characteristics: average ratings, by type of college and institutional characteristic.

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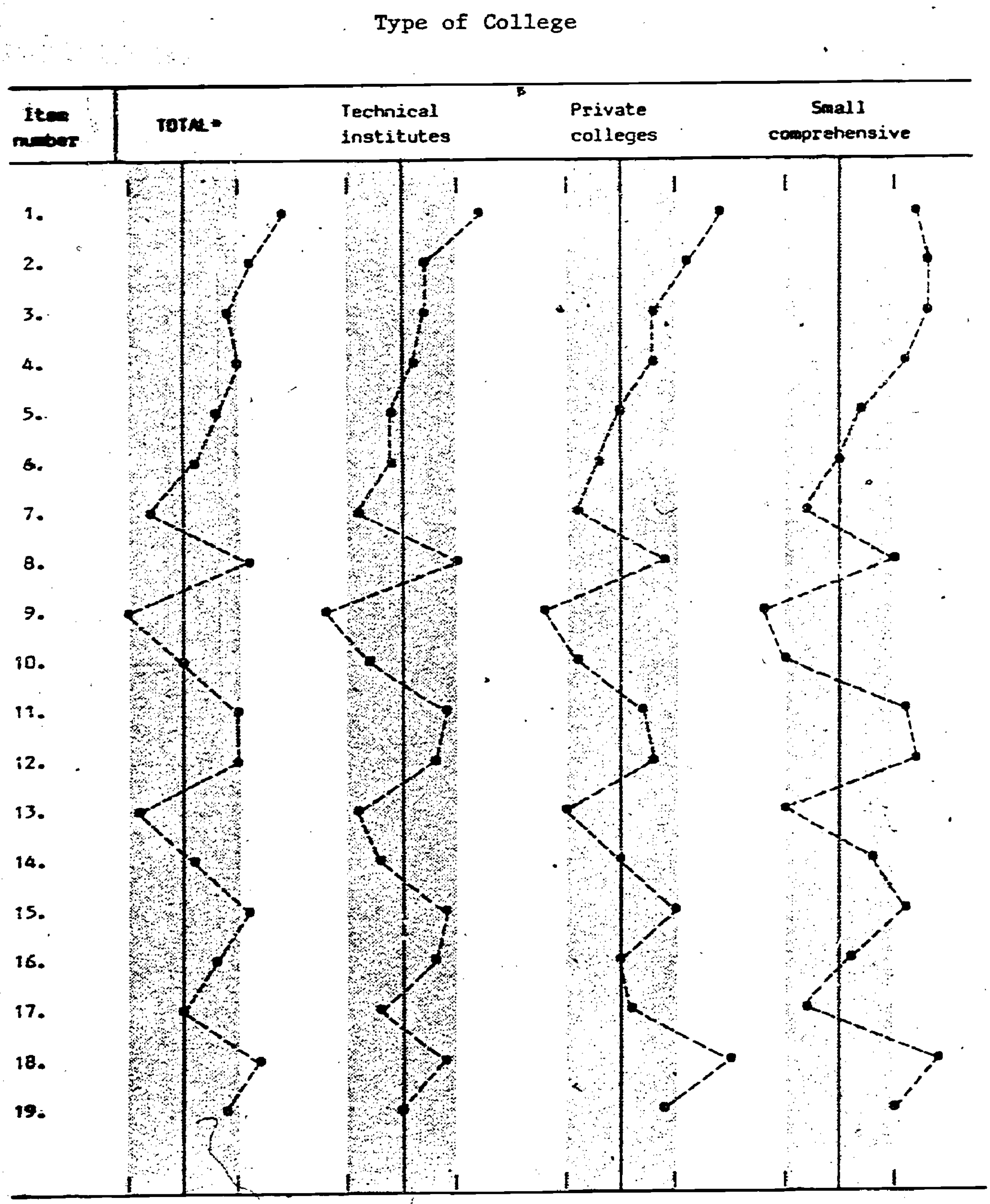
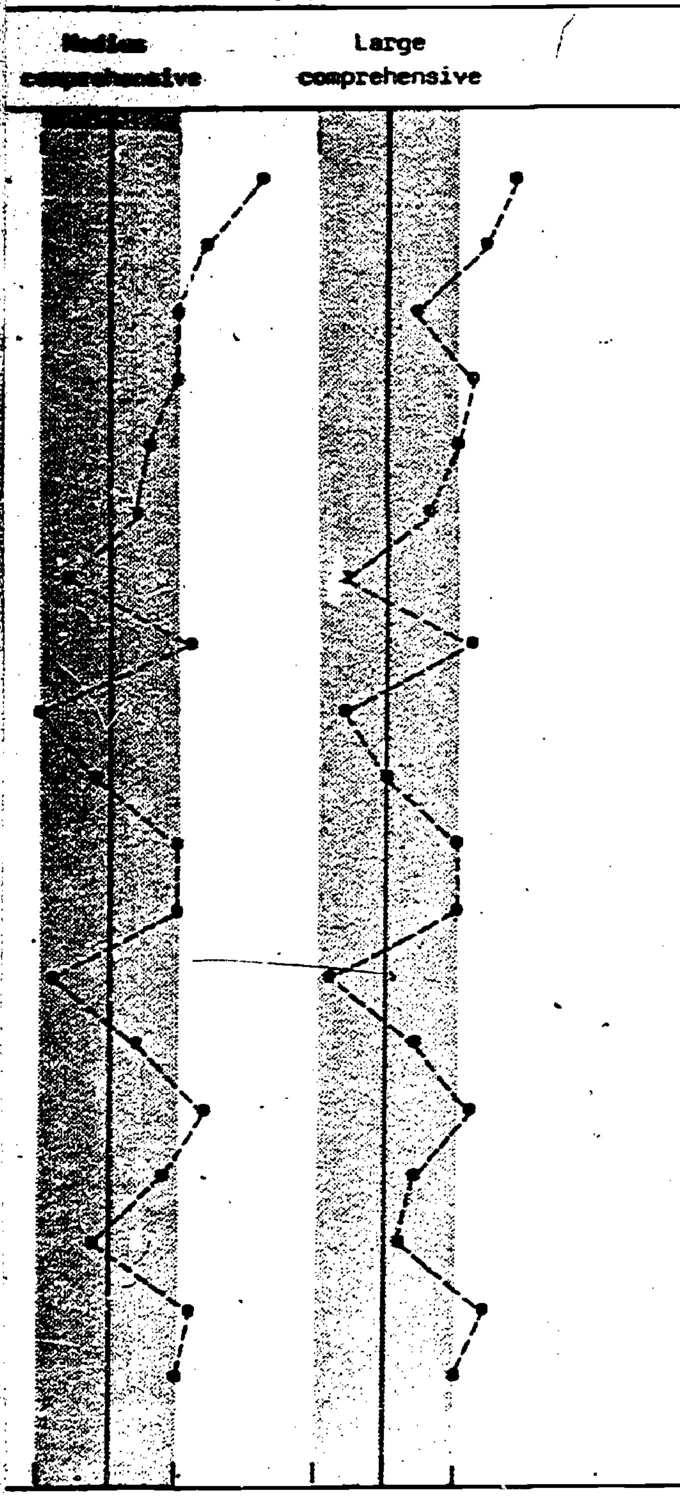


*Shaded area represents the middle range (2.5-3.5) on the five-point scale.

Figure 5-6 (continued). Faculty assessment of 19 institutional characteristics: average ratings, by type of college and institutional characteristic.

Type of College



Key to institutional characteristics

1. Course structure
2. Classroom/lecture facilities
3. Class preparation areas
4. Lecture-demonstration facilities
5. Laboratory facilities
6. Laboratory apparatus and equipment
7. Budget for laboratory equipment and supplies
8. Laboratory usage
9. Instructional technicians (laboratory aides) -- quantity
10. Instructional technicians (laboratory aides) -- quality
11. Availability of teaching aids (films, other media)
12. Size of classes
13. Prior preparation of students
14. Clerical support
15. Library
16. Availability of professional journals
17. Opportunities for professional growth
18. Teaching environment
19. Articulation with transfer institutions' policies on transfer of credits

Figure 5-7. Faculty Assessment of 19 institutional characteristics: average ratings, by educational field and institutional characteristic.

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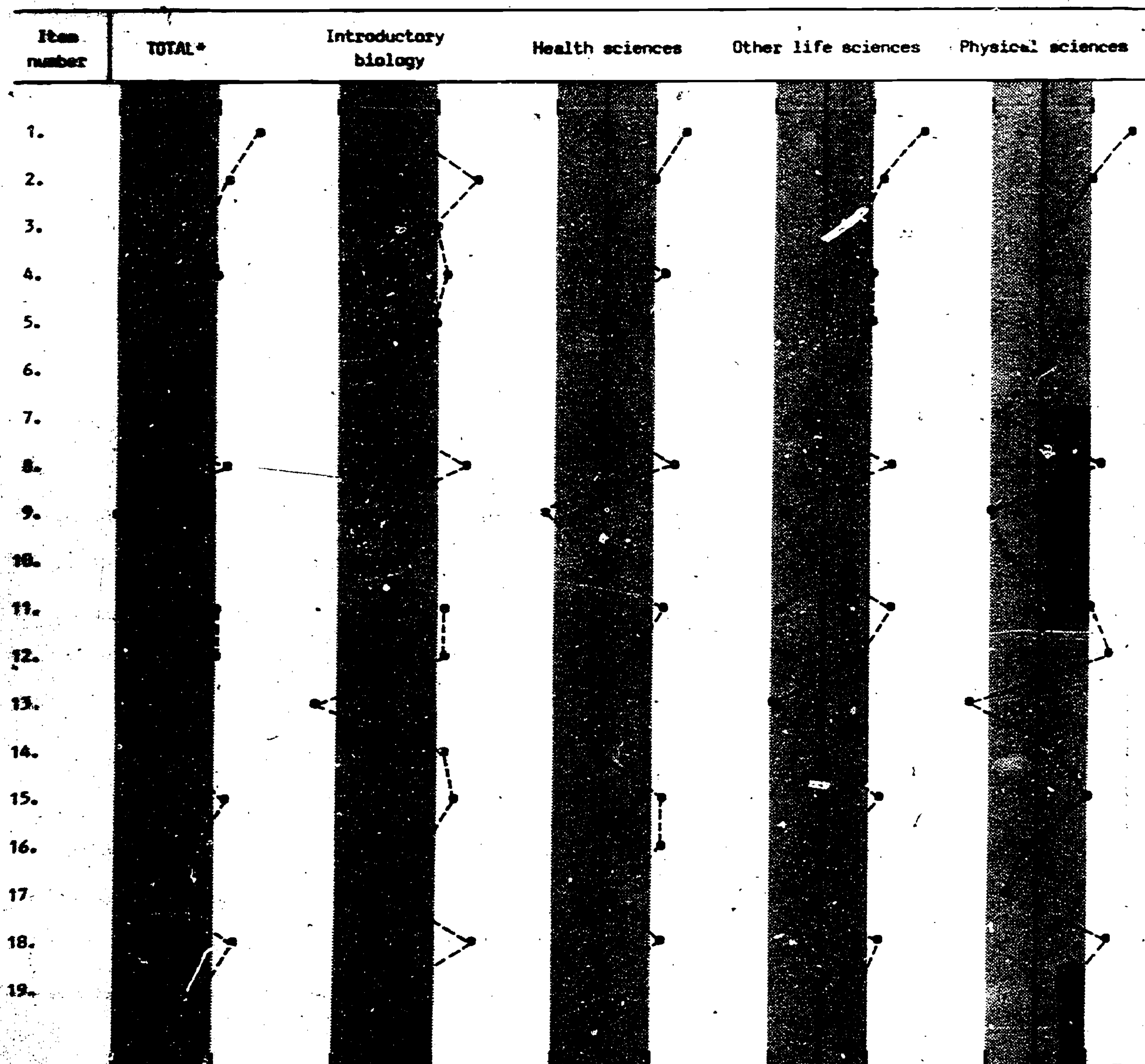
Educational Field



*[illegible] area represents the middle range (2.5-3.5) on the five-point scale.

Figure 5-7 (continued). Faculty assessment of 19 institutional characteristics: average ratings, by educational field and institutional characteristic.

Key to institutional characteristics

1. Course structure
2. Classroom/lecture facilities
3. Class preparation areas
4. Lecture-demonstration facilities
5. Laboratory facilities
6. Laboratory apparatus and equipment
7. Budget for laboratory equipment and supplies
8. Laboratory usage
9. Instructional technicians (laboratory aides) -- quantity
10. Instructional technicians (laboratory aides) -- quality
11. Availability of teaching aids (films, other media)
12. Size of classes
13. Prior preparation of students
14. Clerical support
15. Library
16. Availability of professional journals
17. Opportunities for professional growth
18. Teaching environment
19. Articulation with transfer institutions' policies on transfer of credits

colleges. Those in mathematics and engineering and technology appear to be less satisfied than faculty in social sciences and health sciences. An interesting split occurs, however, between the career fields (health sciences, engineering and technology, and computer sciences) and the more traditional subject areas (introductory biology, physical sciences, mathematics, and social sciences) on a number of items. Faculty in the career fields are more satisfied with the prior preparation of their students than are faculty members in the other fields, although only by a small margin; none rates this item very high. Faculty in the career fields are less satisfied with the adequacy of laboratory facilities, size of classes, and provision of clerical support.

5.8 Priorities for Improving Science Education

Question: *Of the [19] institutional characteristics that you indicated . . . as needing improvement, select the three which you consider as having top priority . . .*

This question provides another way of evaluating the 19 college characteristics listed in the preceding question. It is a measure of what the faculty respondents believe to be the most important obstacles to the improvement of the quality of education at their institutions.

The items that were most frequently rated as either first or second priority are shown in Table 5-13. Theoretically, if faculty members indicated particular dissatisfaction with certain institutional characteristics in the preceding question, then they should rate those same items high on this question.

The characteristic most frequently rated by faculty as an obstacle to educational quality is student preparation (32

Table 5-13. Percent distribution of faculty assigning first or second priority to institutional characteristics in need of improvement, by characteristic: all faculty combined

Characteristic	Percent of faculty
Prior preparation of students	32
Budget for laboratory equipment and supplies	21
Laboratory facilities (space)	15
Laboratory aides (quantity)	15
Opportunities for professional growth	14
Clerical support	12
Laboratory apparatus and equipment	11
Size of classes	10

percent). Budget for laboratory equipment and supplies is next highest (21 percent), followed by laboratory facilities (space) and laboratory aides (quantity), with 15 percent each.

These faculty priority ratings are shown in more detail by college type and educational field in Appendix D. All types of colleges agree that the top priority is student preparation, but their ordering of other items varies. For private colleges the highest priorities are laboratory equipment and size of classes; for small comprehensive schools, they are laboratory facilities (space) and budget for laboratory supplies. Both the medium and large comprehensive schools agree that budget for laboratory supplies takes second place.

The variation among educational fields is considerably greater. When faculty responses are viewed by field, prior preparation of students is not the most important item. A split in responses occurs between the fields that are more general in nature, serving a variety of students (introductory biology, physical sciences, mathematics, and social sciences) and the more occupationally oriented fields. In mathematics and social sciences, for example, over 40 percent of the faculty respondents are concerned about student preparation. Among the occupational fields, the greatest concerns of faculty in computer science are laboratory equipment and the budget for laboratory supplies. Faculty members in the health sciences believe they need better laboratory space. In engineering and technology, budgets for supplies and laboratory aides are considered obstacles to improving educational quality.

6. STUDENT NEEDS IN TWO-YEAR COLLEGE SCIENCE EDUCATION: THE STUDENT PERSPECTIVE

All students were asked a series of questions on their reactions to the science courses they were taking. In addition, if they were majoring in one of the science fields, they were asked to respond to a set of questions about the science programs in which they were enrolled. Students' responses to these questions are discussed below.

6.1 Students' Evaluation of Science Courses

Question: *How do you rate the quality of instruction in this science course?*

The rating scale for this question contained five points, ranging from 'excellent' to 'very poor' with a midpoint indicating 'average.' 'Excellent' was coded as 5, and 'very poor' as 1. The average ratings are shown in Figure 6-1 by college type and educational field. The average rating given by all students is 4.1, or slightly above average. All subgroups of students rated the quality of instruction between 4.0 to 4.3. On the basis of these responses, it may be concluded that students have generally positive feelings about the quality of instruction in the science courses they are taking.

Question: *How well does what is being taught in this course meet your educational needs?*

A five-point rating scale was used, ranging from 'completely' to 'not at all,' with the midpoint indicating 'half way.' The scale was coded as follows: 'completely' = 5, and 'not at all' = 1. The average student rating is 4.1 (see Figure 6-2).

Figure 6-1. Students' assessment of the quality of instruction in their science courses: average ratings, by educational field and type of college

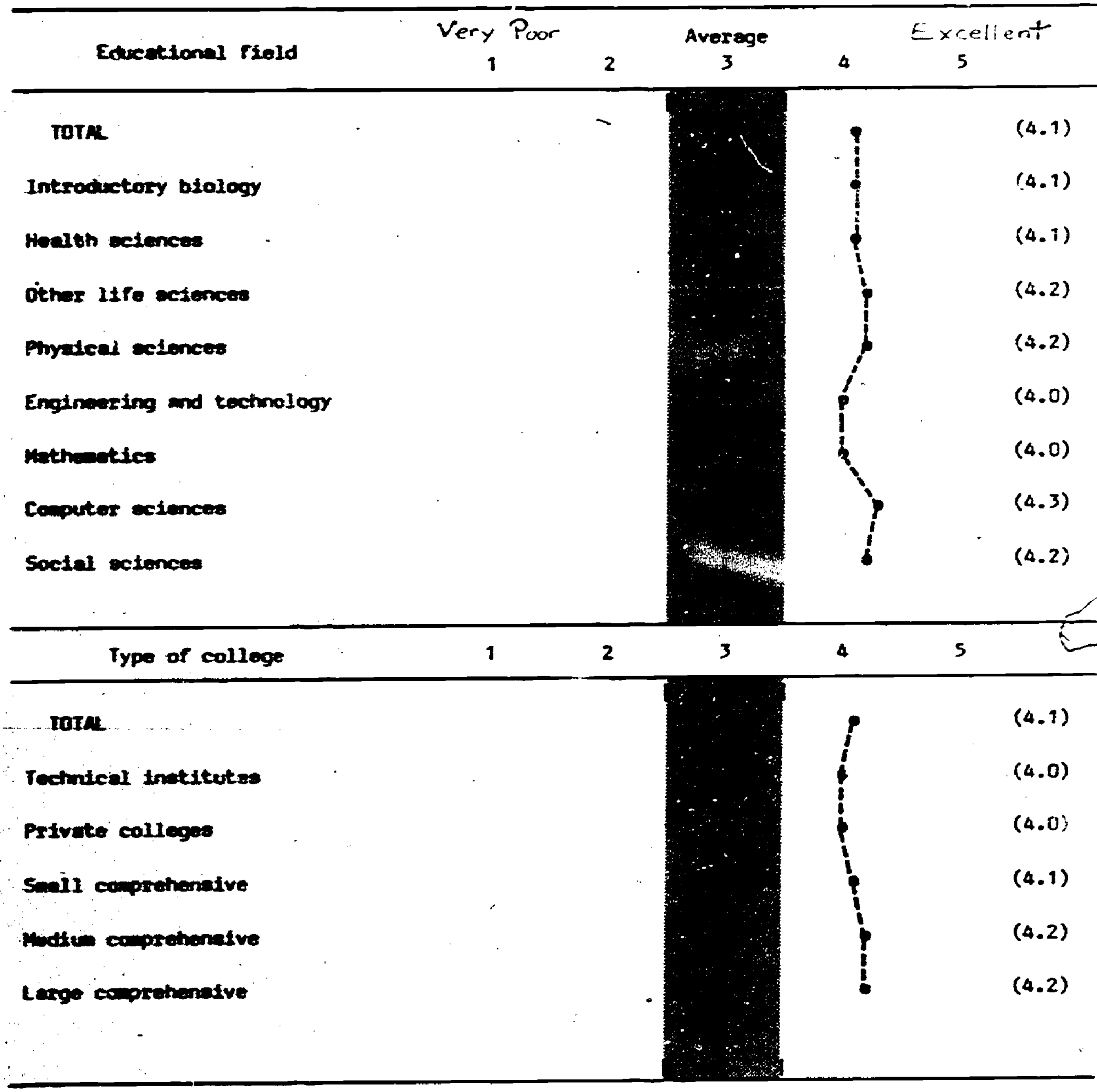
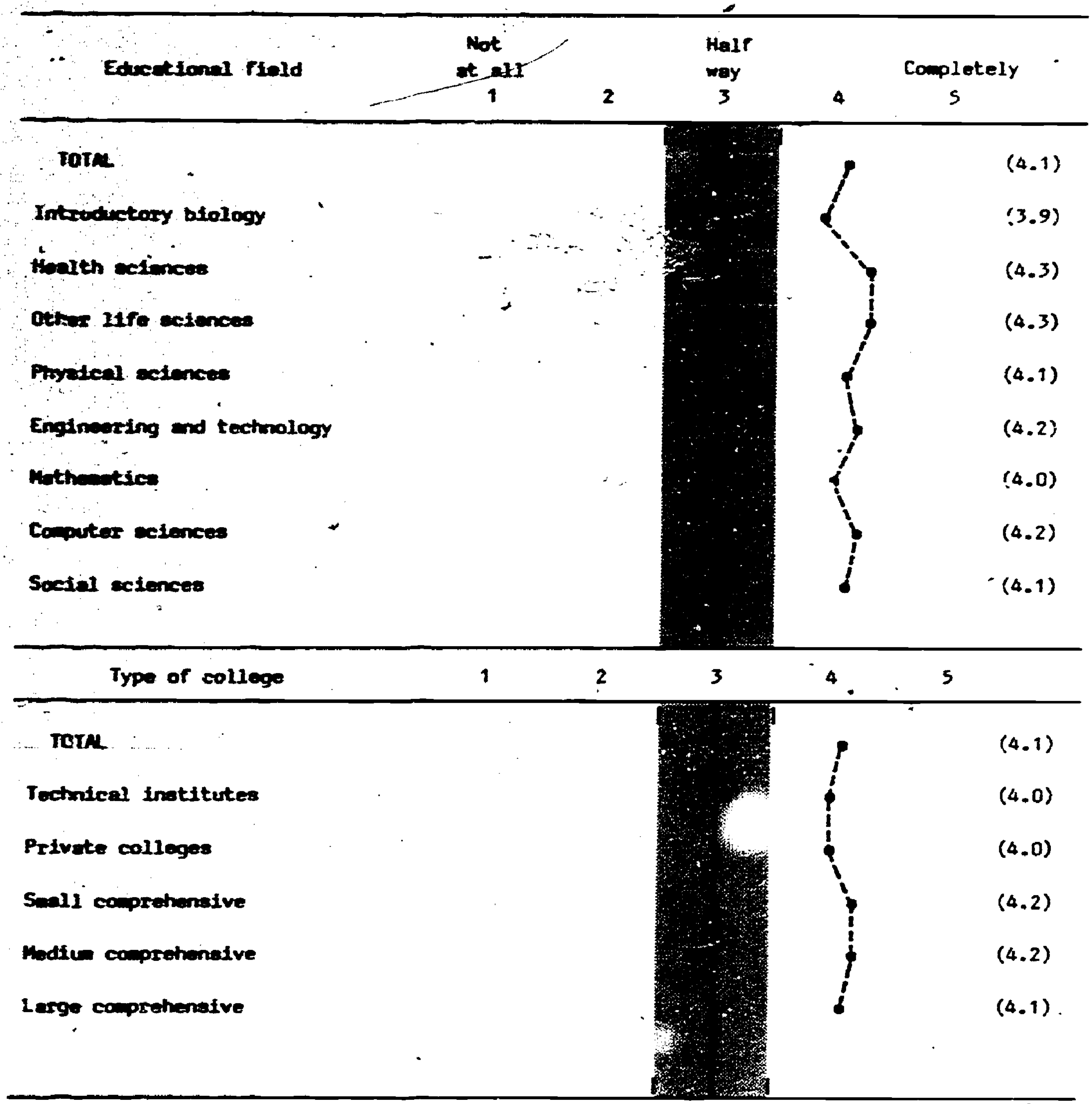


Figure 6-2. Students' assessment of how well their science courses meet their educational needs: average ratings, by educational field and type of college



As with the ratings of instructional quality discussed above, there is little variation among subgroups. By college type the range is from 4.0 to 4.2, and by educational field the range is from 3.9 for introductory biology to 4.3 for both the health sciences and other life sciences. Again, students' needs seem to be met adequately.

Students' ratings were further analyzed by racial/ethnic group and by sex (see Figure 6-3). Results show that with the exception of black women, all other women perceive that their educational needs are better met than men perceived them to be. Asian males and Hispanic males are the least satisfied among the subgroups.

<u>*Question:*</u> *Would you recommend this science course to a friend?*

The answer choices were 'yes,' and 'uncertain.' Figure 6-4 shows the proportions of students answering 'yes.' The average for all students was 82 percent. By type of college, the range was 75 percent for small comprehensive schools to 84 percent for medium comprehensive schools. By educational field, the variation was wider, with mathematics at 71 percent, physical sciences at 77 percent, and computer sciences at 87 percent. All of these ratings indicate that students are highly satisfied with the science courses in which they are enrolled.

However, there are differences in the responses to this question among minority groups and women and men. According to Figure 6-5, Asian, black, and Hispanic women are more satisfied with their courses than are men in the same groups. The reverse is true for American Indians and Alaskan Natives. The difference between white men and women is negligible. Asians are the least satisfied of all groups, with Asian males in particular falling

Figure 6-2. Students' assessment of how well their science courses meet their educational needs: average ratings, by racial/ethnic group and sex

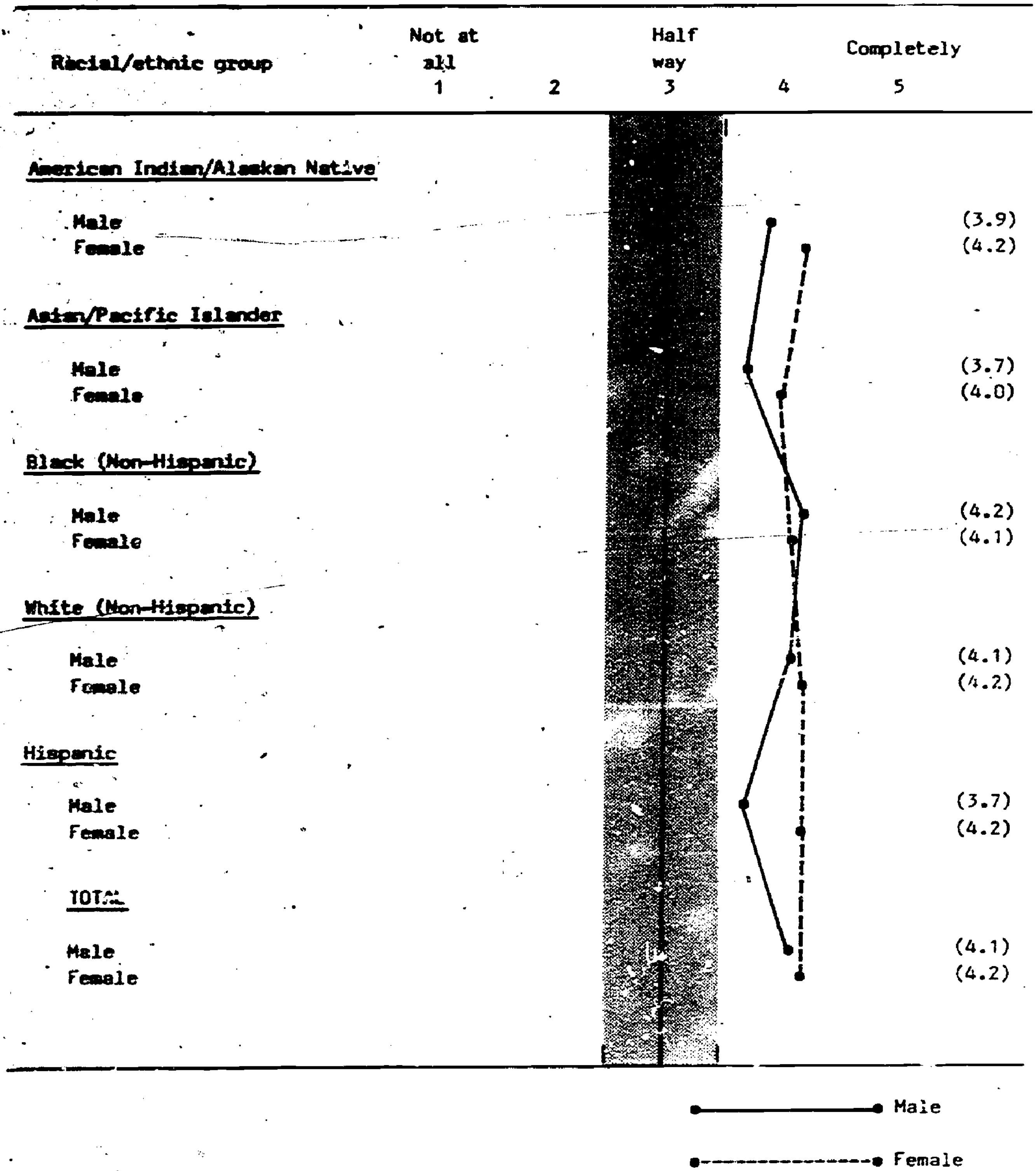


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Figure 6-4. Percent distribution of students who would r· :ommend their science courses to friends, by edι·cational field and type of college

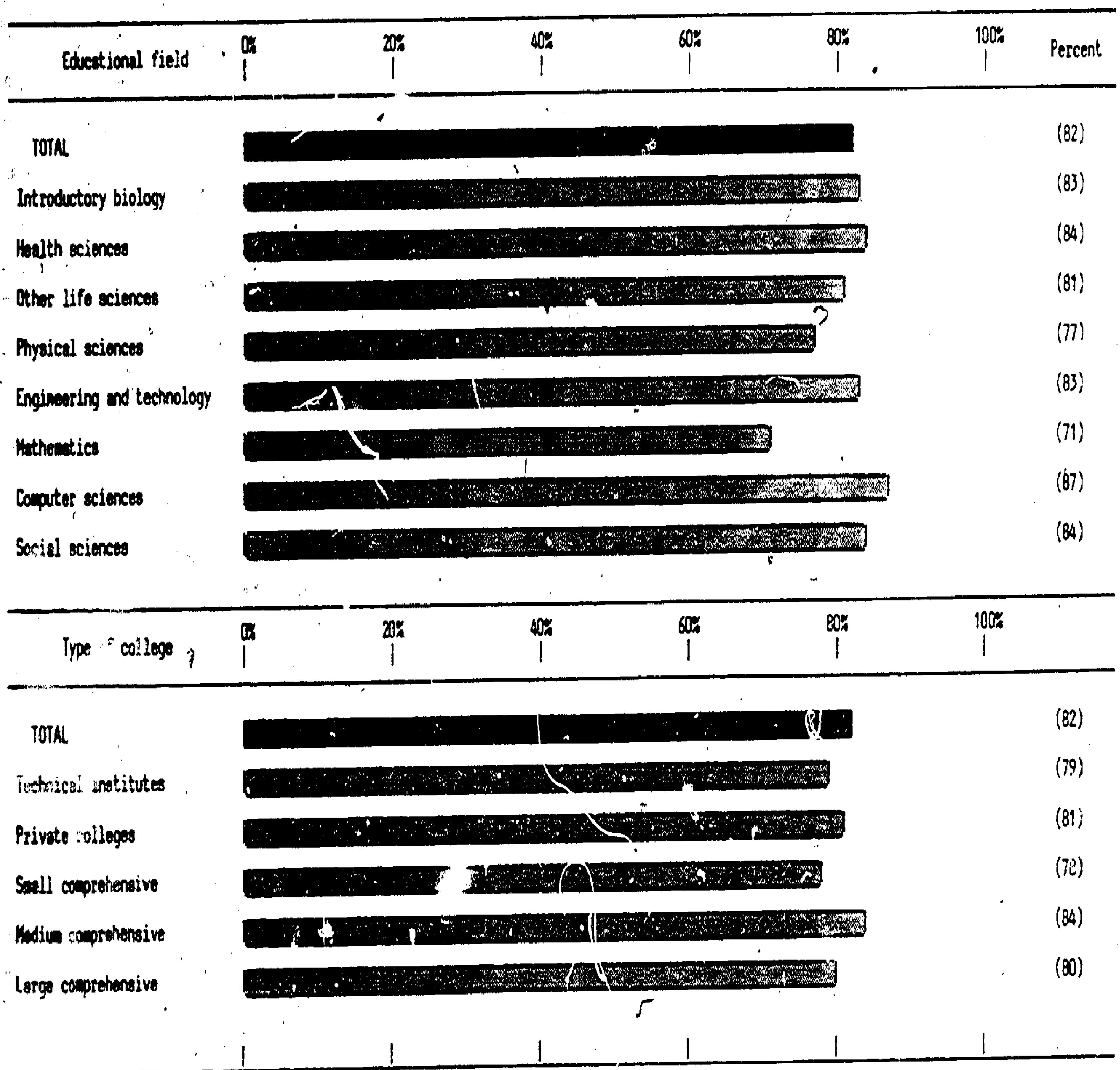
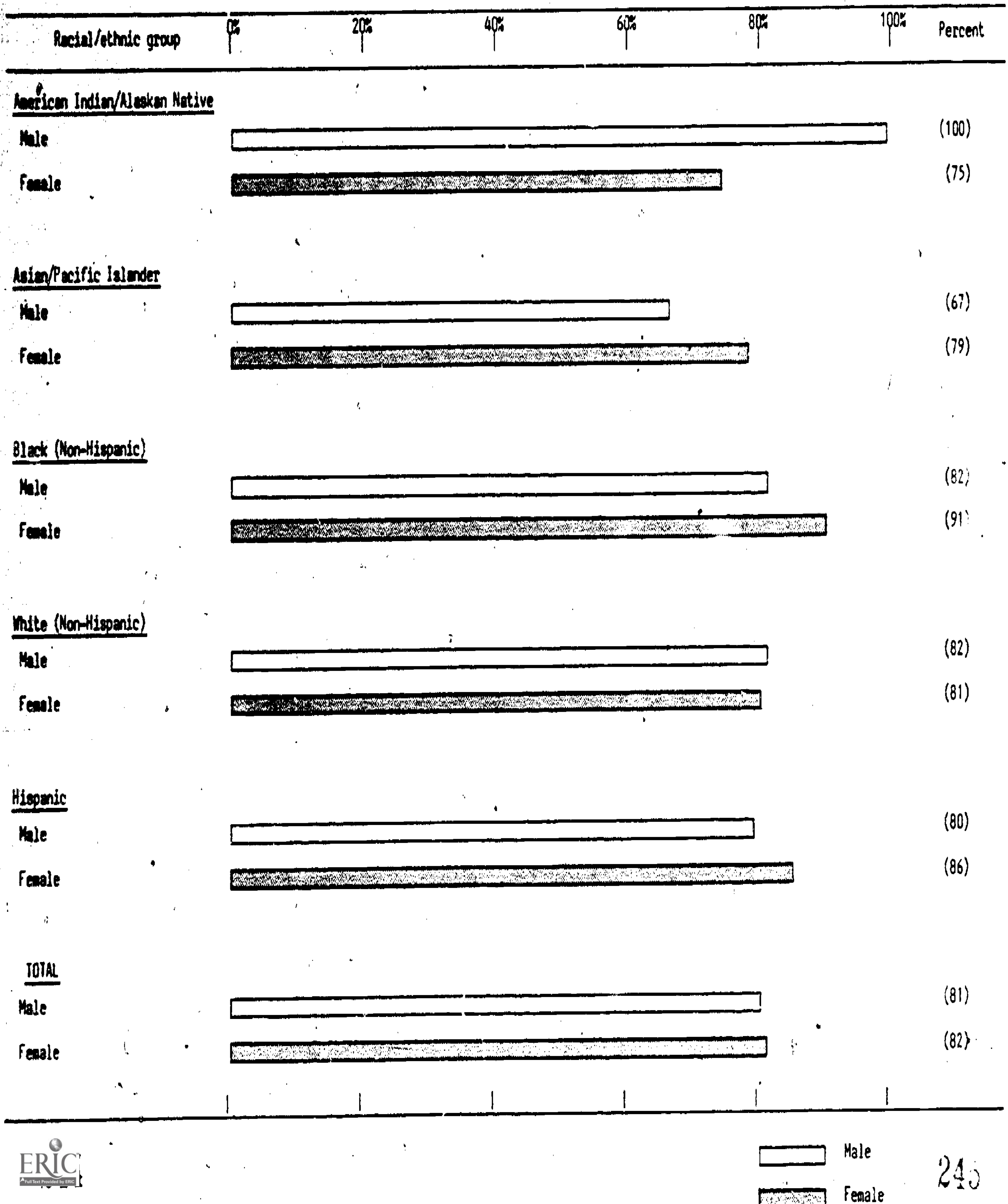


Figure 6-5. Percent distribution of students who would recommend their science courses to friends, by racial/ethnic group and sex



way below the mean for all males (67 percent, compared with 81 percent for all males).

6.2 Science Majors' Evaluation of Science Programs

Students who declared majors in the disciplines included in this study were designated science majors. They were asked two questions about their science courses similar to those answered by all students, as well as a question on the characteristics of their science programs. It should be noted, once again, that some students included in the survey are not science majors, even though they are taking science courses. These students are excluded in this part of the evaluation.

<u>*Question:*</u> *As a person majoring in one of the science fields, how much do you believe the science program in which you are enrolled meets your educational needs?*

A rating scale of five points, ranging from 'completely' (coded 5) to 'not at all' (coded 1), was used. As shown in Figure 6-6, the average rating given by all science majors is 4.2. This relatively high rating indicates that science majors are generally well-satisfied with their programs. There is very little variation by college type or educational field. The highest rating was given by health science majors. Their average rating is 4.4, as compared to 4.0 designated by computer science or social science majors.

When analyzed by racial/ethnic group and sex, as shown in Figure 6-7, the data indicate the similarity of men's and women's evaluations of their programs, although women average slightly higher than men. The ratings by racial/ethnic groups are not significantly different from each other.

Figure 6-6. Science majors' assessment of how well their science programs meet their educational needs: average ratings, by educational field and type of college

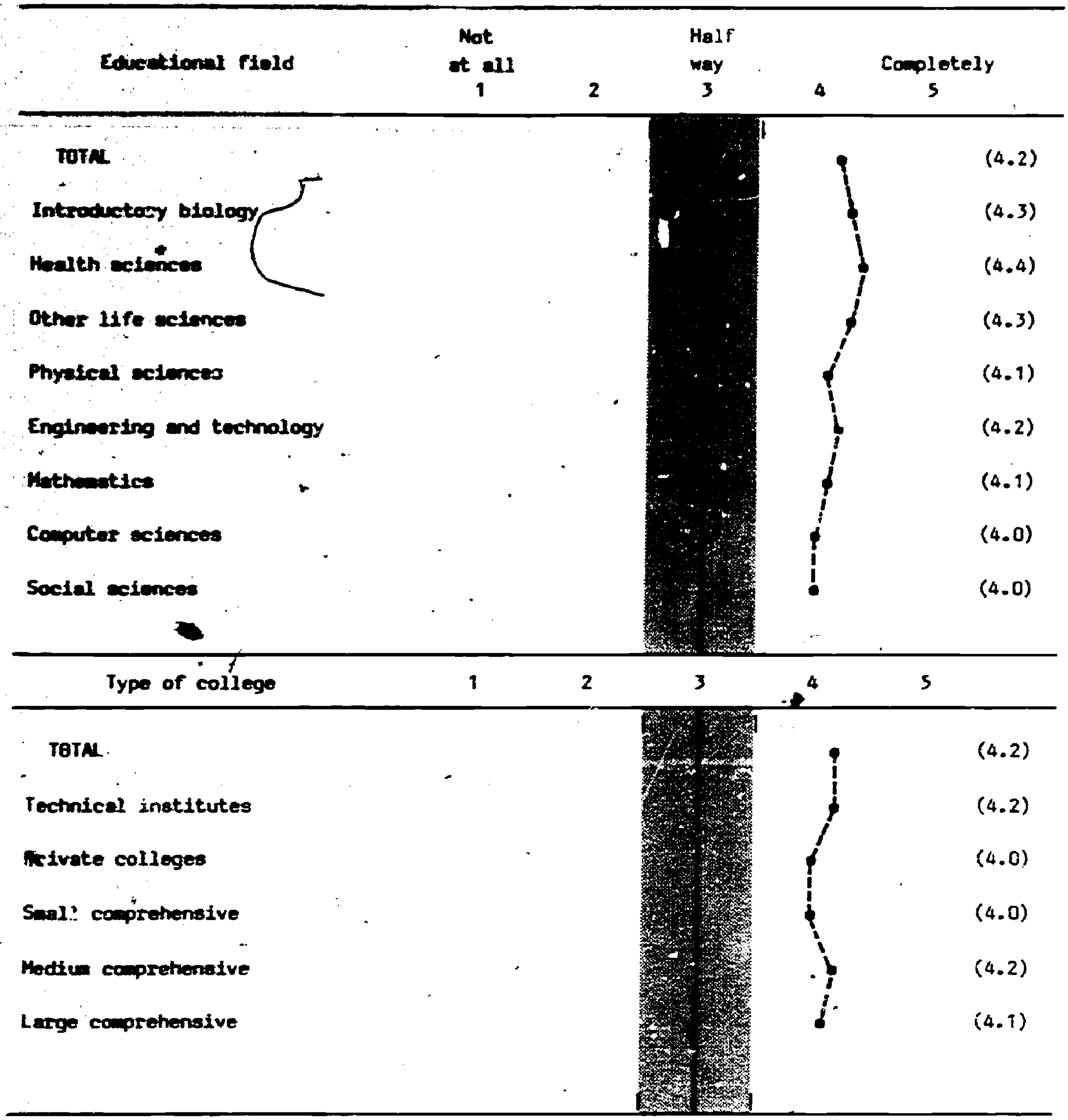
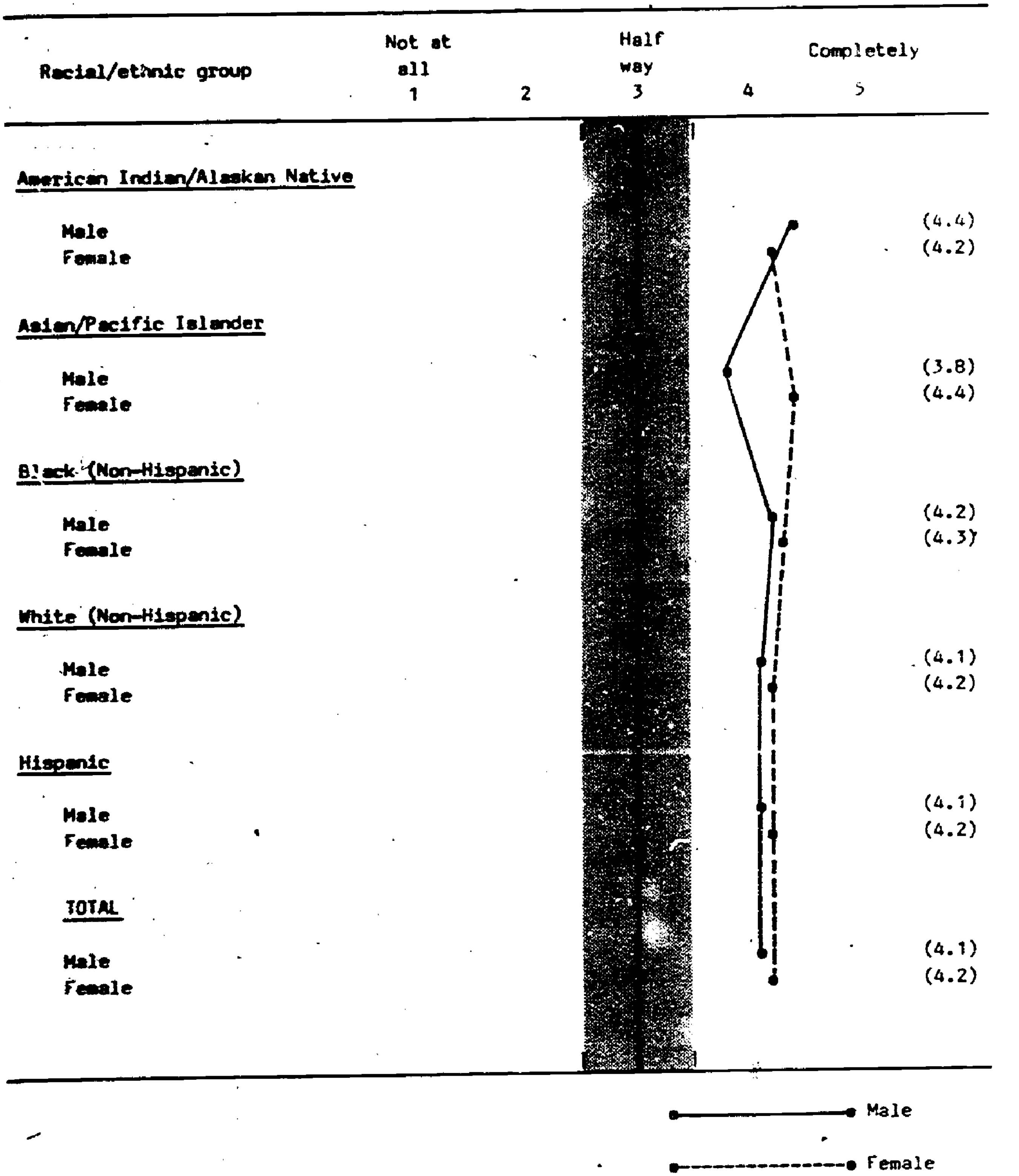


Figure 6-7. Science majors' assessment of how well their science programs meet their educational needs: average ratings, by racial/ethnic group and sex



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<u>Question</u>: Would you recommend the educational program or major field in which you are enrolled to a friend?

The possible answers were 'yes,' 'no,' and 'uncertain.' Figure 6-8 shows the average percent of students answering 'yes' (85 percent of all science majors). However, there is considerable variation among subgroups. It was found that 91 percent of the science majors in technical institutes would recommend their programs to friends, while only 71 percent of those in both private colleges and small comprehensive schools would do so. The range by educational field is from 90 percent for computer sciences to 66 percent for introductory biology. The low value for introductory biology may be explained by the fact that all those not answering 'yes' answered 'uncertain.'

Racial/ethnic groups also show substantial differences in responses to this question. As Figure 6-9 indicates, all American Indian and Alaskan Native students answering this question gave positive replies. Asians again assigned lower ratings; only 71 percent of the Asian men and 81 percent of women answered 'yes' (the rest were uncertain). Blacks, on the other hand, reacted highly favorably, with 95 percent of the men and 92 percent of the women answering 'yes.'

<u>Question</u>: Below are some important characteristics [10] of the science program of this college. Rate how satisfied you are with each characteristic, using a code of 1 for <u>totally dissatisfied</u> and 5 for <u>totally satisfied</u>.

Characteristics of science programs rated in this question include curriculum structure, curriculum advising, college facilities, course scheduling, class size, library, and audio-visual materials. Average ratings of these characteristics are presented in Figure 6-10. The lowest rating is for curriculum

Figure 6-8. Percent distribution of science majors who would recommend their educational programs or major fields to friends, by educational field and type of college

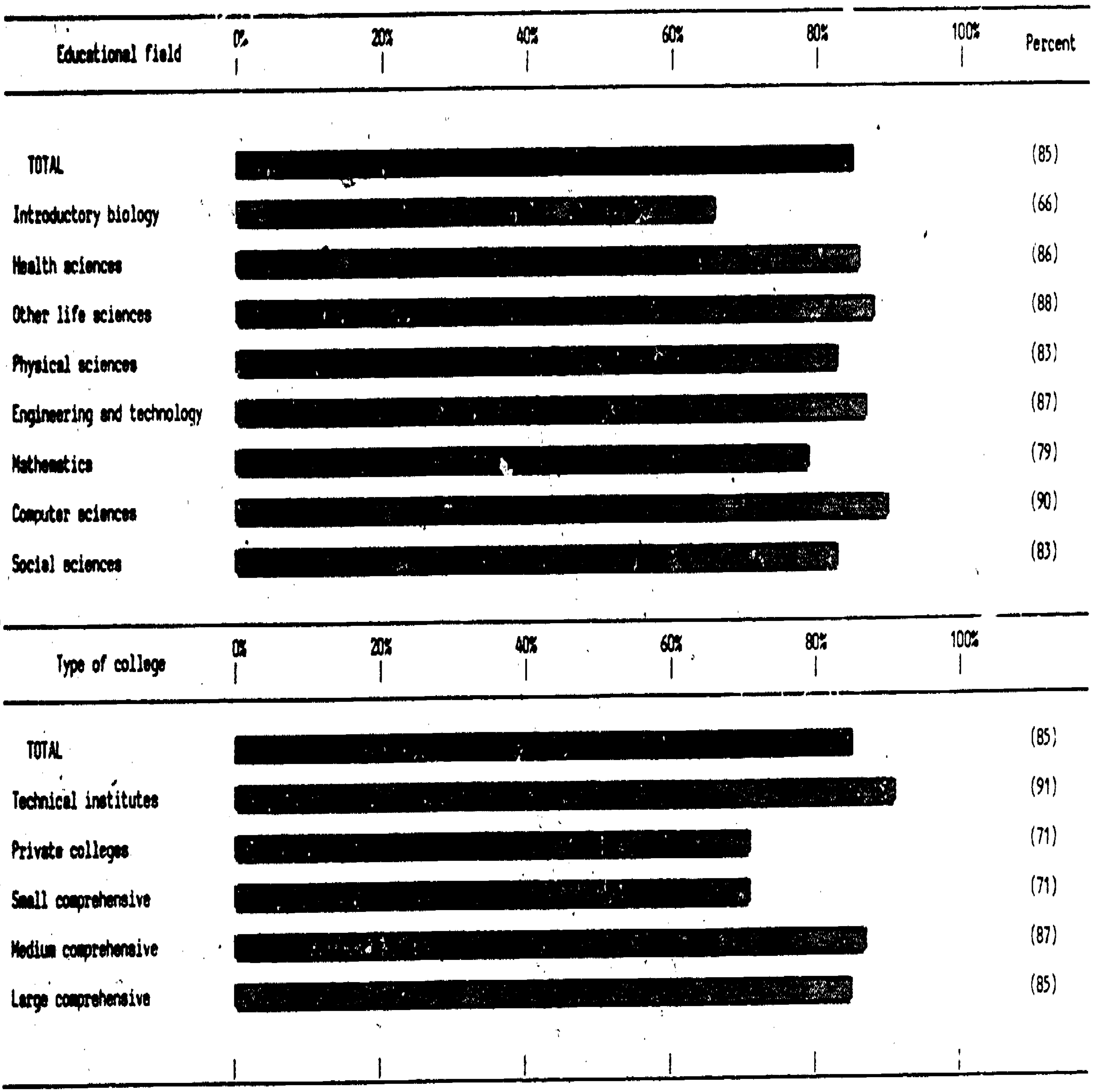


Figure 6-9. Percent distribution of science majors who would recommend their educational programs or major fields to friends, by racial/ethnic group and sex

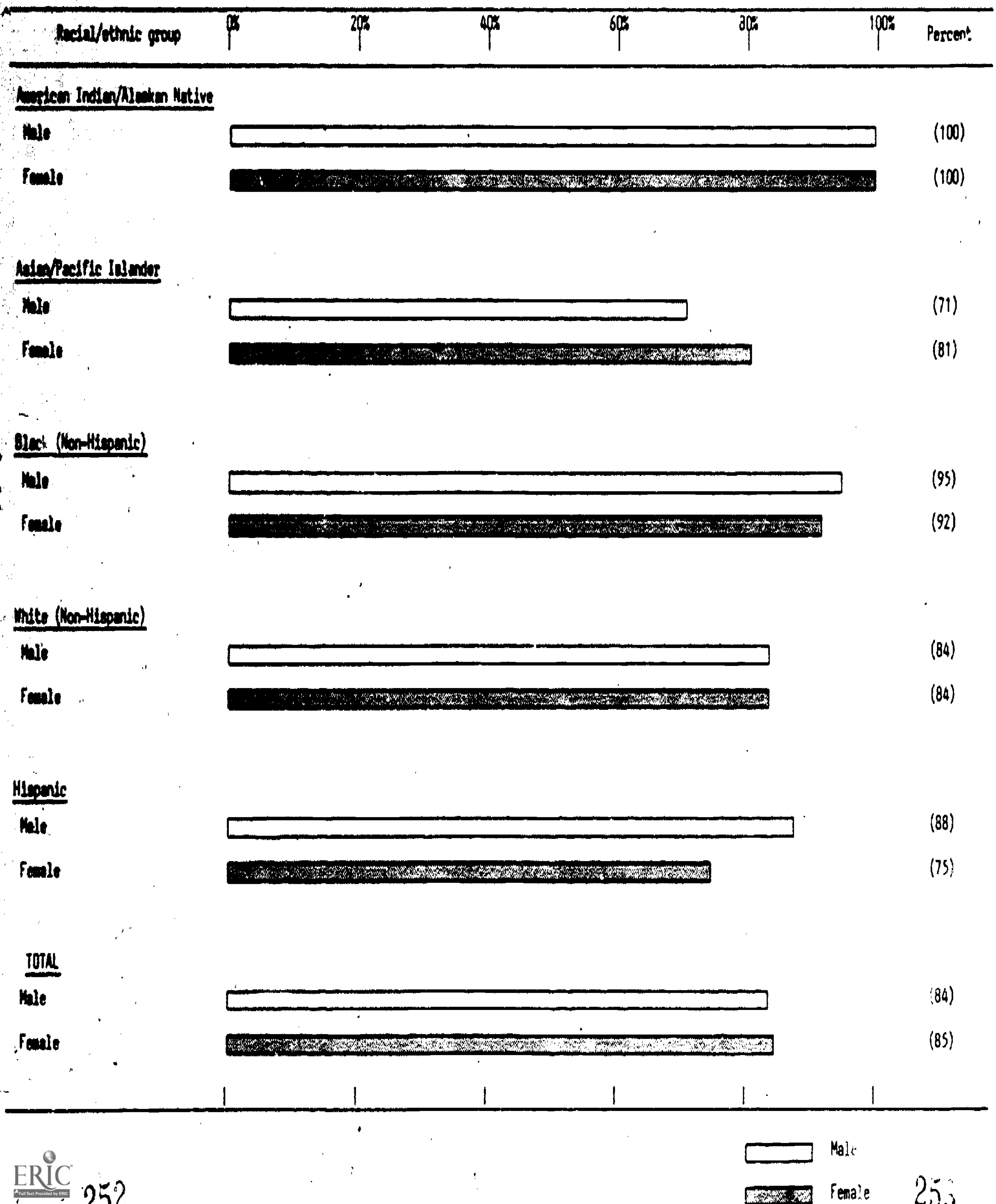
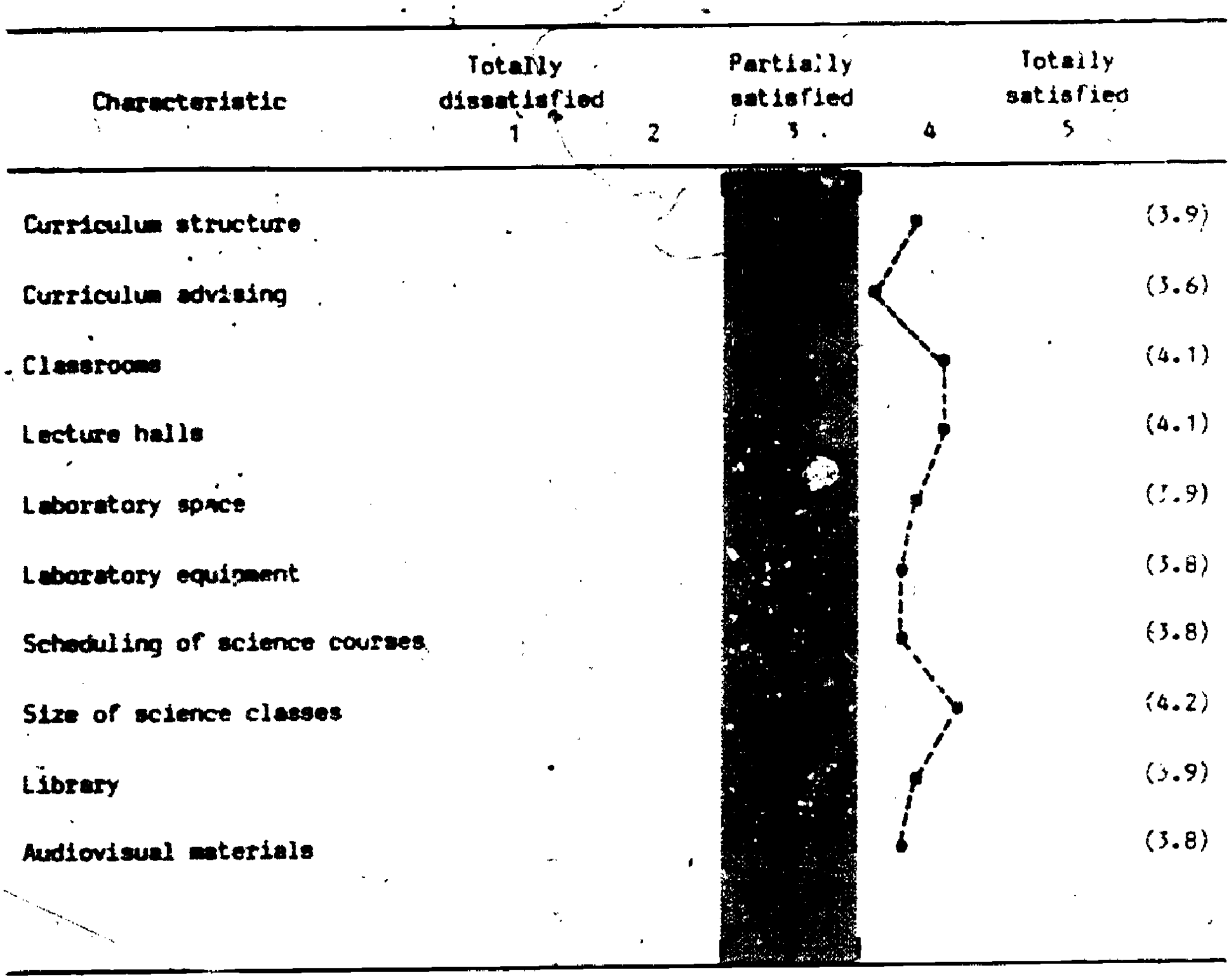


Figure 6-10. Science majors' assessment of characteristics of their science programs: average ratings, by characteristic



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advising, and the highest is for class size. However, the range of these averages is not great (3.6 to 4.2), showing a reasonable level of student satisfaction with their science programs.

Each of the 10 program characteristics is examined below. Mean ratings for these items, by college type and educational field, are given in Volume 2, Appendix D.

Science Curriculum:

- Curriculum structure. There is little difference in average ratings among college types and educational fields. The average for all science majors is 3.9. Technical institute science majors gave ratings only slightly higher than those in other colleges. Introductory biology has an average rating of 4.2, with the health sciences at 4.0.

- Curriculum advising. Overall, this characteristic received the lowest rating from students; the average is 3.6. There is little variation by college type. Among the educational fields, the rating from mathematics students is low (3.3), and the rating from introductory biology students high (3.8).

College facilities for science:

- Classrooms. Although the average rating for all students is 4.1, those taking introductory biology courses rated this characteristic very high (4.6), as did students in the other life sciences (4.4) and the physical sciences (4.3). Students taking engineering and technology courses turned in the lowest ratings, with an average of 3.9.

- Lecture halls. This characteristic received a mean average rating from all students of 4.1. Students in private colleges and small comprehensive schools assigned this characteristic the lowest ratings (3.7), while those in medium comprehensive schools indicated the most satisfaction (4.3). Lecture halls were rated high by students in introductory biology and other life sciences, whereas health sciences students were the least satisfied.

- <u>Laboratory space</u>. Although the average rating by all students is 3.9, students enrolled in private colleges are the least enthusiastic about their laboratory space (3.3). Once again, introductory biology students turned in high ratings (4.4), and computer science students indicated the least satisfaction (3.3).

- <u>Laboratory equipment</u>. This characteristic received an average rating of 3.8 from all students. As with laboratory space, private college students and students taking computer science courses assigned their laboratory equipment the lowest marks (3.4 and 3.2, respectively).

- <u>Library</u>. The average rating by all students for libraries is 3.9. Students in private colleges and in computer sciences are the least satisfied, with each group assigning its libraries a rating of 3.5.

- <u>Audiovisual materials</u>. An average of 3.8 was given by all students to this item. However, private college students assigned it 3.4, and students enrolled in technical institutes gave it 3.5. Computer science students indicated the least satisfaction with a rating of 3.3.

<u>Science classes</u>:

- <u>Scheduling of science classes</u>. The average rank assigned by all students is 3.8, with students in private colleges giving the lowest ratings (3.7) and those in small comprehensive schools the highest (4.1). Mathematics students are the least satisfied with course scheduling, rating this characteristic at 3.6, while introductory biology students are the most satisfied, rating it at 4.3.

- Size of classes in science. This item merited the highest level of approval, with an average of 4.2. Private college students rated class size at 3.6.

7. SUMMARY, DISCUSSION, AND RECOMMENDATIONS

This study has provided a considerable amount of information about the status and needs of science education in two-year colleges. Specific results were presented in Chapter 3 through Chapter 6. This chapter summarizes the major findings and discusses their implications. Recommendations based on these findings also are presented.

7.1 Overview of Institutional Needs

The extent of need for improvement in science education varies by type of institution. Throughout this study the data have shown that marked differences exist among the five types of colleges. However, in general, medium comprehensive colleges are perceived as more closely meeting the needs of students and faculty than other types of schools. Medium comprehensive schools, those enrolling between 1,500 and 7,500 students, received the most favorable responses of all college types on items measuring science education needs. Next most favorably rated are the large comprehensive schools. On most variables the medium and large comprehensive colleges are ranked at the high end of the scale, joined on occasion by other college types. On a few variables, large comprehensive schools received the highest ratings. They have the highest percentage of faculty with doctorates, even though relatively fewer of their faculty members have participated in NSF programs. More men than women students attend large comprehensive schools, and 44 percent of their students are part-time. Most of the Asian and Hispanic students are enrolled in large comprehensive colleges. The median student age is nearly 23 years.

Small comprehensive colleges definitely differ from the two larger types. They offer very little, compared to other comprehensive schools, in science-related career programs. They have only small proportions of students who attended other colleges prior to enrollment in their present colleges. Students choose this type of college for its convenient location 90 percent of the time, far more than for any other type. Fifty-five percent of the small comprehensive college students are in social science courses, compared to 45 percent for all colleges combined. These students are relatively unhappy with the science facilities and laboratory equipment in small comprehensive schools.

The proportion of part-time faculty in these schools is quite small. Almost half of the full-time faculty are between the ages of 30 and 39. More of these faculty than in any other type of college have attended NSF programs, but they report less recent involvement in self-improvement activities than faculty in other schools. Their current need for substantial preparation in courses that they are now teaching is higher than for other groups.

Administrators acknowledge the past participation of small comprehensive college faculty in NSF programs by rating faculty as having a low need for teaching improvement. They also agree that their faculty members have not recently engaged in self-improvement efforts. These administrators are not satisfied with their libraries or their audiovisual materials. Their greatest need for improvement in educational fields is in computer sciences (for computer equipment), more so than for any other college type. They currently have no students majoring in computer sciences. Small comprehensive schools rank lower than other college types on measures to encourage women, minorities, and the handicapped in the sciences.

Private colleges are in great need of facilities and equipment for the basic sciences. They have a greater need than other college types for major construction. Their libraries and audiovisual resources are rated low. A large proportion of private colleges does not offer physical facilities to help handicapped students, nor have they done much to encourage their enrollment.

Very few private college students are in the technologies, and none is in computer sciences. Private colleges do enroll a greater than average proportion of students in the health sciences, introductory biology, and other life sciences. This enrollment pattern probably is related to the fact that 72 percent of their students are women. Ninety-two percent of their students attend full-time, and they tend to be a little older than the average. The proportion of black students taking science courses is by far the greatest at private colleges. Students tend to choose private colleges because of their reputations. However, private college students are less satisfied than other students with all kinds of facilities and are particularly critical of laboratory space and equipment. They are not happy with libraries and audiovisual materials either. Class size is a cause of dissatisfaction, and on this point, the private college faculty agrees.

Private college faculty members also agree that laboratory facilities and equipment are not satisfactory, and they are critical of the lack of clerical help. These faculty members generally give their colleges low ratings on many items, but they are very positive about the teaching environment. An unusual aspect of faculty composition at private colleges is the large proportion of part-time faculty who are also college administrators. This phenomenon is not evident in other types of colleges.

Technical institutes show great need for improvement of existing programs and for additional programs, mostly in the technologies and in physical science. Facilities and equipment needs are high, but faculty development is also necessary. A large proportion of the faculty is viewed as needing improved knowledge of content and, especially, more work experience. Nevertheless, the faculty is given credit for a good deal of recent effort at self-improvement.

Proportionally few faculty members in technical institutes have participated in NSF programs; a low percentage holds doctorate degrees. One-third of the faculty possesses only bachelor degrees, or less. An unusually high proportion of the faculty is female. Faculty members agree that laboratory facilities and equipment are not as good as they should be, and they also complain about a lack of clerical help.

Students at technical institutes share faculty and administrator perceptions of the need for better facilities and equipment. On the average, these make up the youngest group of students; 82 percent of them attend full-time. They chose technical institutes both for convenience of location and for college reputation. Over half of these students are men. Twenty-one percent plan to seek employment after earning their associate degrees, the highest proportion for any type of college. Nevertheless, over half of the technical institute students intend to obtain bachelor or graduate degrees. They are, of course, more concentrated in engineering and technology and other career programs than students in other colleges.

7.2 Major Findings and Discussion

As indicated earlier, data were obtained from three sources: college administrators, faculty, and students taking science courses. While each of the three questionnaires focused on issues unique to each group, they also elicited information on certain common concerns, such as equipment and facilities improvement, faculty development, and student needs. Except in a few cases, such as the appropriate composition of faculty (full- versus part-time) and the evaluation of teaching methods, perceptions of needs in science education from all three data sources appear to be highly consistent. This consistency in turn adds credibility to the data provided by the three sources. The major findings are summarized below:

- *Most science fields, particularly computer science, are perceived to be in critical need of improvement.*

As shown in Chapter 4, there are seven fields that were indicated by more than 20 percent of administrators to be critically in need of improvement. In order of importance, these fields are computer science, chemistry, mathematics, physics, biological sciences, nursing, and electronic technologies. Except for the last field, which if offered primarily in technical institutes and large comprehensive schools, the need for improvement in these fields was expressed by all colleges.

The need for improvement in computer science is experienced by faculty and students, as their ratings on a set of science program characteristics indicate. When these ratings are analyzed by educational field, it is found that those teaching or studying computer science show much greater dissatisfaction with the quality of facilities, equipment, and support services than do faculty and students in any other field.

It should be noted that engineering, general science, and interdisciplinary studies seldom are viewed as being in need of improvement. In regard to interdisciplinary studies, it may be that administrators are not fully apprised of the status of this rather amorphous field, or that it is not very common at the two-year college level. As for engineering, it is very difficult to separate this field from the many technological fields that require engineering courses as basic preparation; this proved to be the case when we attempted to select class sections for the faculty and student samples, and it also was indicated when the administrators were asked to designate their fields.

- *Overall, improvements in equipment, facilities, and faculty development are indicated most frequently, but the priorities vary by educational fields and types of colleges.*

Administrators were asked to specify the types of improvement needed for each field. Data show that, for all colleges and all fields combined, the most critical need is for equipment, followed by facilities and faculty development. Course content and educational methodologies were mentioned only about one-third of the time. However, the emphasis varies by educational field. For example, while equipment and facilities are in great need of improvement in engineering and technology, they are less critical than faculty development in the social sciences.

Needs for facilities or equipment analyzed by college type appear to correspond with the degree of involvement of colleges in engineering and technology. Administrators in technical institutes and large comprehensive schools reported relatively more demand for these kinds of improvements than did those in other types of colleges. Of course, the large comprehensive schools (7,500 or more students) have much more extensive physical plants and more complex programs than other types of colleges;

they enroll 42 percent of all students in engineering and technology. On the other hand, technical institutes are smaller on the average, but they have a high proportion of very expensive, specialized facilities that are subject to wear and obsolescence. Therefore, both of these types of colleges, with their large investments in facilities and their strongly expressed need for improvements in facilities and equipment, will require great fiscal resources to upgrade their physical plants. It is interesting to note that the private colleges registered the highest need for general purpose laboratory construction and equipment.

The above findings generally are confirmed by faculty and students, except that faculty and students in large comprehensive colleges, unlike the administrators, tend to be slightly more satisfied with their equipment and facilities. Reasons for this discrepancy are not clear.

- *Needs for computer equipment and for better libraries are expressed strongly by all respondents.*

Over one-third of all college administrators indicated a need for computer equipment or installation. This need is particularly pronounced in small comprehensive schools.

Strong need for better libraries also is expressed by all sources. Among types of institutions, private colleges have the greatest need for library improvements.

- *There is no significant indication of need for revising course content or curriculum structure for existing science programs in two-year colleges.*

Neither administrators nor faculty indicated a strong desire for course restructuring. Students also generally are satisfied with curriculum structure. Based on these findings, it seems reasonable to assume that existing curriculum meets student needs.

- *A substantial proportion of faculty members expresses the need for upgrading their knowledge of content and teaching methods.*

Thirty-one percent of the faculty respondents stated that they were teaching at least one course for which they could be prepared more adequately; the variation among fields ranges from 24 percent in mathematics to 39 percent in computer sciences. When asked whether their knowledge of their fields needed general upgrading for their teaching assignments, 61 percent of the full-time faculty said 'yes,' ranging from 47 percent in social science to an astonishing 81 percent in computer science.

The National Science Foundation's efforts to keep science teachers current in their fields continue at a modest level with the Chautauqua conferences directed toward college teachers. Faculty in the basic science fields report a substantial degree of participation in these programs, which have only been in effect for a few years. Faculty needs for additional education in content, as expressed in this survey, can be met fairly well by the Chautauqua format, although not everyone can take advantage of these sessions. However, administrators do not rate this format favorably as an option for improving faculty subject matter knowledge, preferring instead the summer and academic year institute formats.

The judgment of administrators that faculty members need practical work experience, and that this experience should be acquired during the summer when classes are not in session, should be kept in mind. For those colleges that emphasize career programs, sabbatical-style, academic year work programs would be acceptable in the administrators' view. Industry exchange programs also seem to be desirable.

Faculty members themselves report some degree of participation since 1970 in practical work experience in fields relevant to their teaching areas. The highest proportions are in the career fields (health sciences, engineering and technology, and computer sciences), but the largest is only 38 percent for teachers in computer science.

There is also an apparent need, expressed by administrators, for improvement of faculty teaching methods and attitudes. While some administrators indicated preferences for ways to encourage these improvements, further study seems advisable before recommendations of specific formats are made.

The concern for teaching methods is greatest in the colleges that offer most of the technology courses -- technical institutes and large comprehensive schools. This concern may not arise so much from dissatisfaction with the teaching skills of the faculty as from a desire to help students overcome educational deficiencies. Two-year colleges have publicized their nontraditional approaches to teaching as part of their "open door" policy of student admissions. Nontraditional methods, however, usually require major teacher training efforts. One element often associated with nontraditional methods is student self-assisted learning, with the help of audiovisual materials. Both faculty and administrators are moderately dissatisfied with the software (i.e., the content or message in the media) available to their students, and this dissatisfaction may be an indication of their concern about teaching methods. More study of the need for improved teaching methods is called for.

- *Faculty members in general like their teaching environments, but they express need for better support services.*

In general, faculty members rate their teaching environments positively. Opportunities for professional growth, however, are viewed less favorably, especially by teachers in technical institutes and small comprehensive colleges. On the whole, faculty members perceive a relative lack of support services (clerical assistance, laboratory technicians, and adequate budgets for laboratory supplies). Laboratory apparatus and facilities are not regarded as very satisfactory either. However, they do not complain about class size.

- *Full-time faculty in two-year colleges have heavy teaching loads and spend little time in other professional activites.*

Faculty members report their work week as rather heavy, with an average of 31 hours devoted to classroom teaching by full-time faculty (including actual time in the classroom, laboratory, and class preparation). With other duties, they claim a 45-hour week. The full-time faculty average credit hour load is 11. Overload amounts to one credit hour on the average for the full-time faculty.

Two-year colleges basically are teaching institutions. Even the very few hours the faculty devote to "R&D" activities are likely to relate to curriculum development or other teaching-related activities rather than to basic or applied research. In the estimates of the time they spend in professional activities outside their college duties, research other than that required for advanced degrees does not even appear as a factor. While the absence of research activity may not be a measure of ability or personal preference, it does indicate the stringent demands of the academic environment in two year colleges.

- *Part-time faculty carry a substantial teaching load in two-year college science education.*

Based on faculty responses, about 30 percent of all faculty members in two-year colleges are part-time, with wide variation among fields. Part-time faculty members teach about 16 percent of the total credit hours in all fields combined, ranging from 29 percent in engineering and technology to 5 percent in other life sciences.

Regardless of the overall supply of teachers qualified for full-time faculty positions, part-time faculty always will be necessary. Extra class sections are formed ad hoc from semester to semester as enrollment requires, and hiring full-time faculty to teach these sections would not be warranted. Another reason is money; part-time faculty costs much less than full-time faculty. The difficulty of employing qualified persons except on a part-time basis also can be a contributing factor.

Part-time faculty members roughly resemble full-time faculty in demographic characteristics, but they are younger on the average, and more are in graduate school. In the career fields, they are often actual practitioners, spending much or most of their professional time at work in the fields which they teach; this is much less frequently the case in the basic sciences. In mathematics, a large percentage of part-time faculty teaches in high school. Part-time faculty members also have need for further education that differ from those of full-time faculty and that vary by field.

Although there is no agreement on whether the current proportion of part-time faculty is appropriate or not, part-time teachers do play a significant role in science education. Their needs, which are somewhat different from the full-time faculty's, should not be ignored if instructional standards are to be maintained.

- *About 80 percent of science faculty members hold advanced degrees.*

The master's degree is the highest educational level for 62 percent of the full-time two-year college science faculty, and the doctorate for an additional 18 percent. These proportions vary widely by educational field. In the career fields (health, engineering and technology, and computer science) the proportions of faculty with only bachelors degrees or less are significantly higher. At the other extreme, 38 percent of physical sciences faculty members hold doctorates.

The large majority of these graduate degrees are in subject matter fields, rather than in education, and generally in fields closely related to teaching assignments. Even degrees given by colleges of education can be in specific subject areas, such as mathematics or science education. On the basis of the data gathered in this study, it is not possible to distinguish these degrees from the more general education degrees. Since possession of a doctorate degree is not considered necessary for teaching in two-year colleges, the kind of doctorates held by faculty members is less of an issue as long as their knowledge of subject matter for the courses they teach is adequate. From analysis of the degrees held by faculty teaching in the basic fields of biological sciences, physical sciences, mathematics, and social sciences (as opposed to the career fields), it may be concluded that faculty possess good subject matter background preparation.

- *The projected and demand for science teaching manp ds further examination.*

During the years of rapid expansion of two-year colleges, faculty were recruited from several sources. A major source was the high school teacher population. In the sciences and mathematics, although not in technology or other career fields, the National Science Foundation contributed to a massive upgrading of the quality of high school teaching through its institute programs. Very large numbers of experienced high school teachers went to work in two-year colleges during the 1960s and early 1970s.

ese numbers are reflected in the present study. Especially among those teaching introductory biology and mathematics, and to a somewhat lesser extent in the physical sciences, a large proportion of faculty reports precollege teaching experience. In these same fields large numbers of faculty report having attended NSF programs. For example, about 50 percent of both full-time and part-time faculty in mathematics attended summer institutes, and 58 percent of the full-time mathematics faculty had some type of ducational experience.

A smaller number of former high school teachers entered the social science departments of two-year colleges (as contrasted, for example, with history departments), probably because subjects such as psychology, sociology, and anthropology frequently were not taught in high schools. About the same number came from high schools into the career fields in two-year colleges, with varying backgrounds related to the subjects they now teach. NSF was not a major contributor to the movement of teachers to two-year colleges in the career fields, except in the health sciences.

Now that two-year college expansion has tapered off, and, coincidently, most NSF programs for teachers have been phased out, there is no longer a substantial demand for staffing from the high school teacher population. The NSF role becomes instead one of helping to upgrade existing college faculty and not the inadvertent one of qualifying high school teachers to become college faculty. To meet the need for new faculty in two-year colleges, a more normal pattern of recruitment should be sufficient for the basic science fields. Four-year colleges for the most part are not hiring new faculty, and the pool of qualified teachers should be temporarily in balance with demand.

Recent trends, however, make a word of caution necessary. A shortage of teachers of science and mathematics in the high schools is developing, despite falling enrollments. The proportion of undergraduates interested in the high school teaching profession has dropped close to the vanishing point from the high rates of the late 1960s. This decline in interest is likely to affect the pool of potential two-year college science and math teachers.

Whereas supply is a matter of conjecture, demand also raises some questions to which there are no clear answers. Will two-year colleges continue to expand, albeit at a much slower rate than over the past twenty years? Their expansion probably will have to be at the expense of four-year colleges, which increasingly are establishing themselves as competitors for the two-year college student market. Will the changing character of the student population (more adults, women, and part-time students) cause changes in the types of faculty required? One potential issue that may not arise, at least in the 1980s, is the problem of faculty retirement. At present the proportion of faculty members over age 50 is not high enough to disrupt the job market, if the total number of faculty remains steady.

The stable teacher supply for the basic sciences may not hold for career fields. Colleges report a large demand for career programs. If there is an expansion of these fields, the supply of qualified faculty may not be sufficient to meet the demand. The very factors that create this demand (i.e., the desire for jobs and their availability) establish competition between industry and two-year colleges for qualified personnel. This problem requires further examination.

- *A substantial proportion of science students in two-year colleges lacks adequate language, study, and math skills.*

It is generally acknowledged that many students enter colleges of all kinds without skills considered necessary for a college education. Because of the role of two-year colleges, a greater concentration of such students is to be expected in these institutions. One question addressed to both administrators and faculty was concerned with the level of skills among students in the sciences and technology.

Both groups rank language skills as the primary student problem at their colleges, with administrators more frequently assigning it first priority. Whereas the second priority of administrators is math skills, for faculty it is study skills.

However, variations exist among institutions. At technical institutes faculty rank all three basic skills as having approximately equal priority for their students, while administrators assign lesser importance to study skills. A contrasting pattern is found in private colleges, where faculty rate language and study skills about equally and administrators weight language far more heavily; both agree on a lower priority for math skills.

The emphasis on the priority of needs for these basic skills also varies according to educational field. There is a split between the perceptions of faculty in the career fields (health, engineering and technology, and computer sciences) and those who teach introductory courses in the basic sciences as core courses for degree programs (introductory biology, physical sciences, mathematics, social sciences). Faculty in the career fields and, in this instance, in physical sciences place considerably greater emphasis on math skills than do faculty in the basic science fields. For the basic sciences, study skills rank a strong second to language, whereas math skills were rated second for career fields. Even mathematics faculty assign greater importance to language skills (followed by study skills) than they do to math skills.

- *Students in science education generally are satisfied with their courses and programs.*

Perhaps the most significant evaluation rendered by students is reflected in response to the question, "How well does what is being taught in this course meet your educational needs?" Over 40 percent said 'completely.' A majority of the students indicated that they would recommend their courses to friends. If students were science majors, they evinced an even higher degree of satisfaction with their major fields.

Students are most pleased with class size and relatively less pleased with curriculum advising than any other items. In general, students in the two larger types of comprehensive colleges are most satisfied; private college student ratings are consistently lower.

Despite a tendency for students in career fields to show some dissatisfaction with their classroom and laboratory facilities and, to a lesser degree, with their laboratory equipment, these same students are the most enthusiastic about their needs being met and about recommending their courses to friends. Paradoxically, the students most eager to give high recommendations are those in computer sciences, although they are consistently the least satisfied with many ch :acteristics of their programs. They apparently were able to disregard percep:ions of inadequacies in their physical surroundings and sense the value of the educational programs in this field.

- *Science education programs i wo-year colleges provide a substantial number students with an opportunity to change their careers.*

Eight percent of the students taking science courses in two-year colleges already have college degrees, associate or higher. Another 30 percent previously attended other colleges without obtaining degrees. Two-thirds of these students now are pursuing major fields different from those they previously followed. This proportion is even higher in the three career fields, ranging from 77 percent in the health sciences to 79 percent in computer sciences. In fact, 22 percent of those in computer sciences already have college degrees in other fields.

This history of earlier college attendance is evidence of career switching, in this case to fields holding promise of employment. One of the avowed functions of the two-year college is facilit tion of career changes for adults, and these findings are a sign of such activity.

Previous college attendance is relatively high in technical institutes, with 80 percent of these students changing majors; but it is quite low at small comprehensive schools and private colleges. The career orientation of the technical institutes probably accounts in part for this difference, which also is reflected in the two larger types of public comprehensive colleges. The shifts from earlier educational patterns apparently are related to the variety of career offerings in colleges. Thus, private colleges and small comprehensive schools attract very few students who have had previous college experience since their offerings are minimally career oriented, at least in the sciences and technologies.

- *Students enrolled in technical institutes and in career-related programs have difficulty continuing their education in four-year institutions.*

About the same proportion of students in career programs as those in other educational fields intends to obtain baccalaureate and advanced degrees. Almost half plan to transfer to four-year colleges, with or without associate degrees. However, acceptance of two-year college credits depends strictly on whether they are judged equivalent to credit courses offered by the institutions to which students are transferring. Most comprehensive and private colleges have worked out transfer agreements with at least some of the institutions at which their students are accepted. Technical institutes are less able to make such arrangements.

In general, the traditional college curriculum courses are transferable, whereas occupational courses are not as acceptable. Some courses may be accepted but not credited toward a bachelor degree in a student's major field, as is frequently the case with courses in the technologies. Often, four-year colleges offer no equivalent courses, even if they are technically oriented institutions. Both administrators and faculty in career programs are concerned about this problem. Since well over half of the students in career fields intend to seek bachelor or graduate degrees, the credit transfer problem will continue to pose a barrier for many students. Requirements for completing two-year college programs can conflict with requirements for four-year college degrees, and students are caught in between. Better articulation obviously needs to be developed.

- *There are as many women as men in two-year college science education programs, but women still concentrate in the social sciences and life sciences, while men are in the physical sciences and engineering and technology.*

About the same proportion of women as of men take science courses in two-year colleges. However, more women enroll in the social sciences and life sciences. Men concentrate in the physical sciences and engineering and technology; they constitute a substantial majority of mathematics and computer sciences students. The greatest contrasts are in the career fields, with the health sciences enrolling 86 percent women and engineering and technology enrolling 82 percent men.

If more women are to participate in male-dominated fields such as engineering and technology, they will have to enroll in larger numbers in the physical sciences and mathematics -- the essential prerequisites for entry to technology courses. They evidently are not doing so now, for only 38 percent of physical science students and 41 percent of mathematics students are female. Even when they take physical science and math classes, it is largely because of requirements for degree programs in fields other than science.

Nevertheless, 51 percent of both men and women who take science courses consider themselves science majors. If any increase is to take place in the number of women in the sciences and technology, it probably will not be among the full-time students. Data show that proportionally more full-time women students than men students are science majors. Part-time women students potentially could increase the number of women students in the sciences and technology. Five-eighths of all women students in two-year colleges attend part-time, but only one-sixth of these students are in science. However, part-time women students are demographically different from full-time students. Their median age is 31, 10 years older than the median age of full-time women students. Their needs and backgrounds will have to be analyzed further to determine whether they are likely recruits for science and technology fields.

- *Differences in science education enrollment patterns exist among racial and ethnic groups, but reasons for these differences are not clear.*

In two-year colleges each racial and ethnic group has a unique pattern of participation in science education. Although American Indians and Alaskan Natives constitute only 1 percent of the two-year college population, 2.5 percent of the students in science courses are from this group. A similar pattern exists for Asians and Pacific Islanders, who make up 2.5 percent of the total enrollment, but 3.6 percent of the enrollment in science courses. Blacks and Hispanics, on the other hand, have much lower rates of participation in science courses, compared to their proportions in the total student population.

Black women concentrate in the health career fields but are underrepresented in the physical sciences and technology. Black men are underrepresented in all fields; they do not participate in science and technology at levels anywhere close to their numbers in the total student population. This deficiency, which is the largest among all minority groups, indicates the inadequacy of the measures that have been taken to encourage the entry of black men into these fields.

A similar statement can be made for Hispanics, for both men and women. Even though administrators and faculty proclaim positive action to encourage minority group participation in

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science and technology, very large discrepancies between minority group representation in the two-year college population as a whole and minority enrollment in science courses still exist. However, since the purpose of this study was not to chart trends or to measure change over time, there is no way of estimating whether this situation is improving.

7.3 Recommendations

Based on the study findings, the following actions to improve science education in two-year colleges are recommended:

> 1. *A program should be developed, utilizing Federal and state resources, to provide assistance to institutions in accordance with their own priorities for program, facility, and equipment improvement.*

All types of colleges registered need for improvement, although the areas of greatest concern vary among the different types. For example, data show that technical institutes experience urgent needs for upgrading of facilities and equipment in their technology programs. Because of increasing student enrollment in these colleges, their existing physical plants may not be adequate to meet the anticipated demands for new and expanded programs. Thus, improvements in facilities and equipment, as well as faculty development, would seem to be these colleges' primary concerns.

Private, nontechnical colleges have inadequate instructional and laboratory facilities and equipment for the basic sciences and for the career fields in which they offer programs. Class sizes tend to be large and support services less than adequate. If these schools are to continue to prepare students for science-oriented careers, or even to offer general education students an adequate understanding of science, they will require considerable strengthening.

Small comprehensive colleges (fewer than 1,500 full- and part-time students) differ significantly in programs and facilities from larger comprehensive colleges. Their offerings in the technologies are minimal and are practically nonexistent in nonbusiness-oriented computer science. Their needs are to expand computer sciences opportunities and to acquire better facilities and equipment.

Medium and large comprehensive colleges need help principally to strengthen their existing career programs and to implement those they have planned, particularly in the technologies and computer sciences.

2. *An expansion of NSF educational development programs is needed in order to provide greater opportunities for faculty members to improve their subject matter knowledge and teaching methods and to gain work experience.*

A substantial proportion of faculty members in both the basic sciences and career fields believes they will benefit from specific content-oriented courses in their fields. Although most faculty members have had opportunities to attend NSF and/or non-NSF programs, many expressed the opinion that costs, distance, and scheduling impose obstacles to their participation in these programs. Thus, in addition to some form of financial support, it is recommended that summer and academic year programs in subject matter areas be provided and that these programs be designed to accomodate students in both basic sciences and career fields.

In addition, faculty exchange programs with industry would be helpful in assisting faculty members to stay abreast of current developments in their fields.

Summer programs are considered preferable, but academic year leave for educational development programs is viewed by faculty as a realistic alternative.

3. *Teaching manpower in science education should be examined in light of supply and demand, and preventive measures should be taken to avoid a shortage of qualified faculty.*

Supply and demand trends for faculty in the basic science fields are not clear. Colleges are no longer growing, which would indicate a reduced need for recruitment. However, teacher shortages in high school mathematics and sciences have been noted recently. These shortages may be felt eventually in two-year colleges, despite the currently stable student enrollment, and certainly may have an impact on teacher preparation programs.

In addition, career programs in science-related fields may be faced with a critical shortage of qualified faculty. Industry and higher education very well may be seeking to recruit the same individuals. This potential problem must be faced by colleges planning program changes; thus, measures need to be taken to ensure an ample supply of qualified faculty, particularly in these fields.

4. *Colleges should expand remedial programs to improve students' language, mathematics, and study skills and should provide improved counseling programs for students who are switching careers or reentering the labor market.*

Both administrators and faculty believe that a substantial proportion of students in science courses lacks adequate language, math, and study skills. To help students successfully complete their science education both in two-year colleges and later in four-year institutions, remedial courses to strengthen their skills in these areas would be helpful.

In addition, many students are switching careers after finding their past ones unsatisfactory or after being unable to find jobs. Others intend to reenter the labor force after working at home for many years. Both of these groups of students are greatly in need of career counseling before they commit themselves to new courses of study.

> 5. *Consideration should be given to conducting further research to examine why relatively large proportions of women and ... e minority group members enroll in certain scien e fields.*

Although more women participate in science courses than do men, they are enrolled primarily in the social sciences and particularly in the life and health science fields. On the other hand, men enroll predominately in technology areas. Thus, it may be concluded that encouragement of women in the physical sciences and technologies is needed. Factors relating to women's choices of fields also should be examined.

The data show that Asians tend to enroll in the physical sciences, mathematics, and the technologically oriented career fields. American Indians, especially the men, enroll in relatively large numbers in the social sciences. Blacks and Hispanics, however, have a disproportionately low enrollment in all science fields. Black men are much less involved than black women, with only about 17 percent of the black men in two-year colleges taking courses in science, as compared to about 25 percent of the women. These percentages contrast with the 30 percent or more of the total student population (full- and part-time) who are in science courses. Hispanic men and women each have a science course participation rate of about 15 percent.

Whether present practices to encourage the enrollment of blacks and Hispanics are succeeding cannot be determined from the study data because they are not trend data. It is clear that additional research needs to be done to determine why members of these minority groups do not participate more frequently in science education.

6. *The problem of articulation with four-year colleges for transfer students in career programs should be examined further and resolved.*

Transfer of credits to four-year colleges is frequently an obstacle for students in career programs. Yet the majority of these students intends to transfer to four-year colleges. Even those not seeking to transfer immediately plan to obtain baccalaureate degrees at later dates. Particularly in the industrial and engineering technologies, transfer of courses is difficult. Articulation with four-year colleges presents little difficulty in the basic science fields, but in the technologies specific courses seldom are comparable from one college to another. There is a gap between students' expectations and the reality of college credit transfer. Institutional policies are at the root of this difficulty, and the effort to remedy it must come from greater standardization of courses and from increased cooperation among institutions of higher education.

We would offer one final recommendation -- the continued monitoring of the status of science education in two-year colleges. Such ongoing examination could be accomplished by the development of a sample survey of the two-year college population (including administrators, faculty, and students) to be used to measure changes against the baseline of data collected during this study. NSF then would have immediate access to enough data to make long-term policy judgements and short-term program changes, with some degree of assurance that these decisions are in the best interests of the two-year college community.